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ANNUAL REPORT 2021-22



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ISO 9001:2015

Centre for High Technology
Ministry of Petroleum & Natural Gas

At a Glance

1. Editorial	02
2. Presentation of Awards for Swachhta Campaign-2021.....	05
3. 41 st Governing Council Meeting of CHT.....	05
4. Executive Committee Meeting of CHT.....	06
5. Scientific Advisory Committee Meetings.....	07
6. Pre-bid meeting regarding RFS issued under PM JI-VAN Yojana.....	09
7. Expert Group Meeting of R&D Projects.....	09
8. Working Group Committee on Crude Selection and Procurement.....	09
9. US-India-Energy Webinar on Transition to Clean Energy Technologies in Refining & Petrochemicals.....	09
10. Working Group Meeting -“Revisiting Report on Enhancing Refining Capacity by 2040”..	10
11. Petroleum & Natural Gas – Research Collaboration Committee.....	10
12. Solomon Presentation on Pipeline Benchmarking Study -2020 cycle.....	10
13. Solomon Result Presentation on Refinery Benchmarking Study – 2020 cycle.....	11
14. Executive Summary Presentation to MoP&NG on Refinery Benchmarking Study Results by M/s Solomon Associates.....	11
15. Activity Committee Meetings.....	12
• 2G Ethanol Technology and Project Execution.....	12
• Fuel & Loss and Energy Optimization.....	14
• Rotary Equipment.....	15
• Environment and Water Management.....	15
• Hydroprocessing and Hydrogen Generation.....	15
16. Processing of Proposals of Oil PSUs seeking relaxation for Global Tender Enquiry (GTE) for Tenders below Rs. 200 Crore.....	16
17. Integrated Monitoring and Advisory Council (IMAC).....	16
18. Meeting with M/s Clariant: Presentation of 2G Ethanol Technology.....	16
19. Meeting with M/s ENI, Italy.....	17
20. New Energy and Industrial Technology Development Organization (NEDO) India hosted “India-Japan Hydrogen Seminar”.....	17
21. CHT focuses on Collaboration with Global Labs.....	18
22. Petrochemical Benchmarking	18
23. CHT Webinar Series.....	18
24. CHT Meeting with M/s Honeywell UOP.....	19
25. CHT Meeting with M/s Fortum Oyj, Finland.....	19
26. CHT Meeting with M/s Praj Industries.....	20
27. Saksham 2022.....	20
28. Digitalization in CHT.....	20
29. Repurposing Natural Gas Pipeline for Transportation of Hydrogen Natural Gas Blend.....	21
30. 75 th Independence Day Celebrations at CHT.....	25
31. 33 rd Foundation day of CHT Celebrations	25
32. Swachhta Pakhwada - 2021.....	26
33. Hindi Workshop organized during Hindi Pakhwada 2021.....	27
34. CHT Hindi Nirikshan by the First Sub-committee of the Parliamentary Committee on Official Language.....	28
35. 73 rd Republic Day Celebrations in CHT.....	29
36. International Women’s Day Celebrations at CHT office.....	30
37. Second Period Audit ISO 9001:2015.....	30
38. 7 th International Yoga Day Celebrations.....	31



From the desk of the Executive Director



Dear Esteemed Readers,

Greetings!!

It gives me immense pleasure to release this Annual report 2021-22 where in CHT's activities undertaken during the year are recapitulated. Besides bringing improvements in the on-going refining, petrochemicals operations, R&D projects in downstream hydrocarbon sector, CHT has also shifted its focus towards newer areas of Bio-fuels, Petrochemicals, Hydrogen, Gasification, Carbon Capture & Energy Storage due to the changing energy landscape of our country. The energy scenario, we expect to see in 2050, will be very different from how it is today. This is a time of unprecedented uncertainty for the energy sector. As the energy demand continues to increase, our preparedness to meet the future energy demand remains a key challenge.

We need to ensure that the developing economies receive the financing and technological know-how, they need to continue building their energy systems, to meet the needs of their expanding populations and economies in a sustainable way. The Indian economy is opening up varied opportunities in the energy sector including steadfast progress towards a low-carbon economy. The government continue to play a crucial role in determining and establishing frameworks for markets to function. Industries and markets need to provide efficient solutions for Clean Energy Transitions for ensuring environmental sustainability. Several technologies that are critical to the achievement of net-zero emissions, such as CCUS, hydrogen, bioenergy, solar, wind etc. look especially well-suited to some of the existing skills, competencies and resources of oil and gas companies. The Indian Refinery and petroleum sector are ushering into a new dawn of innovation led progress. However, this can be achieved with support from all agencies and organizations working with CHT to achieve the goals set by MoP&NG.

This Annual Report highlights the important activities held during the year i.e. Presentation of Swachhta Pakhwada Awards 2021 to Oil & Gas PSUs by Shri Hardeep Singh Puri, Hon'ble Minister of Petroleum and Natural Gas, Housing and Urban Affairs, Govt. of India;

41st Governing Council Meeting of CHT; 31st-32nd Executive Committee Meeting; 91st - 93rd Scientific Advisory Committee Meetings; Meeting of Working Group constituted by MoP&NG for "Revisiting Report on Enhancing Refining Capacity by 2040"; Pre-bid Meeting regarding RFS issued under PMJI-VAN Yojana; meeting of Petroleum & Natural Gas – Research Collaboration Committee; Study Result Presentation to Secretary, MoP&NG by M/s Solomon Associates for Refineries & Pipelines Performance Benchmarking Study - 2020 cycle & Meeting for conducting study on crude selection and procurement. Various Activity Committee Meetings were held on 2G Ethanol Technology and Project Execution, Fuel & Loss and Energy Optimisation, Rotary Equipment, Environment and Water Management and Hydroprocessing & Hydrogen Generation along with new Webinar series commenced by CHT on Crude to Chemicals, Electrolyser, Bio-fuels; Meetings with various technology providers were held i.e. M/s Honeywell UOP, M/s Fortum Oyj, Finland, M/s Praj Industries, etc. to help meet our country's sustainability commitments and achieve Net Zero; EOI for RPIP Phase-2 & Petrochemicals Benchmarking; Saksham Survey 2022; CHT's participation in the New Energy and Industrial Technology Development Organization (NEDO) India Hosted "India – Japan Hydrogen Seminar; CHT along with American Chamber of Commerce in India (AMCHAM) and MoP&NG coordinated a webinar wherein US companies presented technologies focusing on Clean Energy in Refining & Petrochemicals for possible cooperation with Indian Companies from downstream sector, Processing of 414/419 nos. proposals of Oil PSUs seeking relaxation for Global Tender Enquiry (GTE) for Tenders below Rs. 200 Crore, etc.

I am happy to inform that the 25th Energy Technology Meet (ETM) shall be held during 15-17 September 2022 in Mumbai and solicit full support and participation in the meet.

This period also witnessed successful Rajbhasha Hindi Nirikshan of CHT by the First sub-committee of the Hon'ble Parliamentary Committee on Official Language, Celebrations of the 7th International Day of Yoga, 75th Independence Day Celebrations at CHT, second periodic audit of ISO 9001-2015; Technical Workshop on Energy Transition, organisation of fortnightly celebrations of Swachhta Pakwada 2021, Hindi Workshop during Hindi Pakhwada 2021, etc.

In the end, I would like to thank the patronage and guidance received from MoP&NG and the constant support and co-operation received from Indian refining sector.



(Alok Sharma)
Executive Director



Swachhta Pakhwada – 2021 Award Distribution Ceremony



Shri Hardeep Singh Puri, Hon'ble Minister of Petroleum and Natural Gas, Housing and Urban Affairs, Govt. of India (seen in the centre) presented the Swachhta Pakhwada - 2021 Awards on 11th March 2022 to the winners at MoP&NG Shastri Bhawan, New Delhi. Also seen in the pic are Shri Pankaj Jain, Secretary, MoP&NG, along with Award winners from IOCL, ONGC, HPCL & Shri Alok Sharma, Executive Director, CHT.



Shri Hardeep Singh Puri, Hon'ble Minister of Petroleum and Natural Gas, Housing and Urban Affairs, Govt. of India presenting the Swachhta Pakhwada - 2021 Award (1st Prize) to Shri Shrikant Madhav Vaidya, Chairman, IOCL.

Shri Hardeep Singh Puri, Hon'ble Minister of Petroleum and Natural Gas, Housing and Urban Affairs, Govt. of India presented the Swachhta Pakhwada - 2021 Awards on 11th March 2022 to the winners at MoP&NG Shastri Bhawan, New Delhi. Congratulating the winners and the participants of the event, Shri Puri said that among all the central programs, Swachhta is more than a scheme. It not only has the physical targets, but also it is a process aimed at generating higher consciousness about cleanliness. He said that the stakeholders in the oil and gas sector have captured this philosophy in their work and their premises have become top class. The Minister also lauded the sector for its contribution in the national economy. The Minister emphasized on making more efforts to make the country Atamnirbhar in the sector.

Swachhta Pakhwada was organised by Oil & Gas CPSEs, and attached offices of Ministry of Petroleum and Natural Gas during 1st -15th July 2021. Motivational events were organized with full zeal and enthusiasm to encourage the Petroleum sector fraternity for their active participation and contribution towards Swachh

Bharat Abhiyan and making India clean, green and healthy. In order to ensure a healthy competition and more effective outcome of the Pakhwada, "Swachhta Pakhwada Awards" have been instituted for exemplary performance during the fortnight.

A Committee was constituted by Ministry under the Chairmanship of ED-CHT, Deputy Director (E&S), MoP&NG and Members from CHT & PCRA to develop methodology, Index and to rank the performance on the basis of activities done. Based on their performance in the event, IOCL was ranked First, ONGC stood Second and HPCL came Third.

As a result of this initiative led by MoP&NG, more than 2 lakh hygiene kits, around 3 lakh masks and around 1.1 lakh eco-friendly bags were distributed. Around 1.3 lakh trees were planted and more than 7 thousand dustbins installed. During the Pakhwada, 140 plastic waste collection centres were set up and more than 4000 online internal & external competitions were organized which saw an active participation of around seventy thousand people.

41st Meeting of the Governing Council (GC) of CHT

The 41st Meeting of the Governing Council of CHT was held on 23rd March 2022 under the Chairmanship of Shri Pankaj Jain, Secretary, MoP&NG at Shastri Bhawan, New Delhi. The meeting was attended by GC

members from MoP&NG, viz., AS&FA, JS (GP & M), JS (R), OSD(IC) and JS (IFD); C&MD, HPCL; CMD, BPCL; Dir (R), IOCL; CMD, GAIL; CMD, EIL; Dir (Ops), OIL; Director, CSIR-IIP; MD, CPCL; MD (I/c), NRL; MD, MRPL



and ED-CHT. Shri Alok Sharma, ED-CHT, welcomed the Chairman & Members of the GC and other participants to the Meeting. He made a detailed presentation on the progress and status of the following activities taken up by CHT.

- Refinery Performance Improvement Programme (RPIP) (Phase-I & II) of PSU Refineries
- Performance Benchmarking Study of PSU Refineries by Solomon
- Feasibility Study for manufacture of Reference Fuel by EIL & IOC R&D
- MBN Roadmap and Actual Performance
- Petrochemicals Benchmarking Study

- Organisation of ETM
- Catalyst Manufacturing Unit in India
- Status on PM JI-VAN Yojana
- Energy Efficiency Improvement in PSU Refineries
- Treatment of Assets created under R&D projects subsequent to its closure
- Adoption of Annual Audited Accounts for Financial Year 2020-21 etc.

Secretary, MoP&NG advised all refineries to speed up the schemes under RPIP-I as well as expedite GTE clearance for RPIP-II. Deliberations also took place in the meeting for the Pricing formula for 2G Ethanol. It was also decided that IOCL shall take forward setting up Reference Fuel Production Facilities.

Executive Committee (EC) Meetings of CHT

The 31st Meeting of the Executive Committee of CHT was held under the Chairmanship of Shri Sunil Kumar, Joint Secretary (Refineries), MoP&NG through Video Conference on 23rd September 2021. The meeting was attended by DS (BR/OR), MoP&NG; Dir (R), HPCL; MD, CPCL; MD, MRPL; ED I/C (R), BPCL; ED(M&I), IOCL; Head(R&D), HPCL; Head(R&D), BPCL; Head(R&D), EIL; Head (R&D), GAIL; Dir(T), NRL; CGM(T), IOCL. Shri P. Raman, ED (Acting In-Charge), CHT, made a detailed presentation on the progress and status of various activities / initiatives taken-up by CHT since the last EC meeting.



The discussions covered:

- The Refinery Performance Improvement Programme (RPIP) of PSU Refineries
- Performance Benchmarking Study of PSU Refineries & Pipelines through M/s Solomon Associates
- Revisiting Report on Enhancing Refining Capacity by 2040
- Feasibility Study for manufacture of Reference Fuel under make in India by EIL & IOC R&D

- Feasibility Study by M/s LanzaTech for Ethanol Production from Off-gases
- Reduction of Water Footprint in PSU refineries
- Status of Catalyst Manufacturing Unit & Status on PM JI-VAN Yojana

EC approved stage - 3 of study on Reference Fuel with IOC-Panipat refinery streams. EC recommended following items for approval by Governing Council: Adoption of Annual Audited Accounts for F.Y. 2020-21 of CHT and appointment of statutory auditor for F.Y. 2021-22.

The 32nd Meeting of the Executive Committee of CHT was held under the Chairmanship of Shri Sunil Kumar, Joint Secretary (Refineries), MoP&NG through Video Conference on 10th December 2021. The meeting was attended by JS (M), MoP&NG; Dir (R), HPCL; MD, CPCL; MD, MRPL; MD, NRL; ED I/C (R), BPCL; ED(M&I), IOCL; ED I/C, EIL; Head(R&D), HPCL; Head(R&D), EIL; Head (R&D), GAIL; CGM(T), IOCL, ED-CHT

Shri Alok Sharma, ED, CHT welcomed the Chairman and other members of the EC. Shri P. Raman, Director, CHT, made a detailed presentation on the progress and status of various activities / initiatives taken-up by CHT since the last EC meeting. The presentation covered the

- Refinery Performance Improvement Programme (RPIP) of PSU Refineries
- Performance Benchmarking Study of PSU Refineries

- Study on crude selection & procurement
- Feasibility Study for manufacture of Reference Fuel under Make In India by EIL & IOC R&D
- Status of Catalyst Manufacturing Unit
- Status on PM JI-VAN Yojana

EC approved following proposals:

- R&D project (Enrichment of Biogas to Bio-methane using Metal Organic Framework (MOF) based Mixed Matrix Membranes (MMM): IOCL/IIT-B
- Approval of 50% base fee refund to BORL in 2020 Cycle and 50% reimbursement to BPCL-KR/MR

- Cancellation of Refinery Performance Improvement and Innovation Awards for the year 2020-21
- Petrochemical Benchmarking of major petrochemical units of PSU's.

EC recommended following items for approval by Governing Council: RBE for F.Y. 2021-22 and BE for FY 2022-23; Treatment of Assets created under R&D projects subsequent to their closure. Other items discussed were: Petrochemical Performance Improvement Programme (PIIP); Transitioning of Oil & Gas (O&G) sector Towards Net Zero.

Scientific Advisory Committee Meeting

91st Meeting of the Scientific Advisory Committee (SAC) on Hydrocarbons of MoP&NG was held under the Chairmanship of Dr. Anil Kakodkar through Video Conference on 5th May 2021.



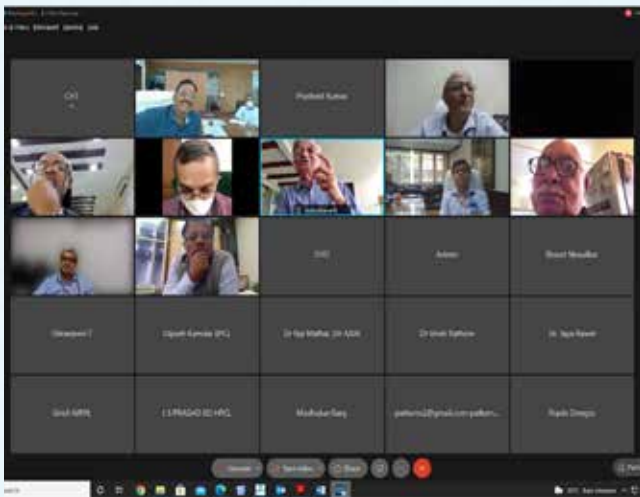
Shri Sunil Kumar, JS(R) informed about the progress in the PM JI-VAN Yojana amendment and mentioned few changes being proposed in the policy. Chairman expressed happiness that the policy is getting broad

based to make it technology agnostic as well as end product agnostic.

During the meeting, SAC deliberated on two new R&D proposals including HCF. After detailed deliberations,

SAC recommended both proposals for funding. SAC also had detailed review of the On-going R&D and HCF projects. SAC also noted the progress of 4 commercial and 1 demonstration projects under PM JI-VAN yojana.

92nd Meeting of the Scientific Advisory Committee (SAC) on Hydrocarbons of MoP&NG was held under the chairmanship of Dr. Anil Kakodkar on 23rd July 2021 through Video Conference. ED-CHT welcomed the Chairman, Joint Secretary (Refineries), other esteemed members of the SAC and special invitees. The meeting was specially convened for discussion on 2G Ethanol pricing mechanism. SAC had extensive deliberations on 2G Ethanol pricing options and gave its recommendations.



Vide Gazette resolution no. R-22012/1/2013-OR-I/E-7712 dated 25th February 2022, the Scientific Advisory Committee (SAC) on Hydrocarbon of the MoP&NG was constituted for a period of three years with effect from 25th February 2022. Subsequently, 93rd Meeting of the Scientific Advisory Committee (SAC) on Hydrocarbons of MoP&NG was held under the Chairmanship of Dr. Anil Kakodkar through Video Conference on 30th March 2022. Shri Alok Sharma, ED-CHT welcomed Dr. Anil Kakodkar, Chairman, Shri Sunil Kumar, Joint Secretary (Refineries), other esteemed members of the SAC and special invitees. On this occasion, SAC remembered Late Prof. R. Kumar, an esteemed SAC member since October'2010 and paid respect by observing 2-minute silence in honour of him.



Dr. Anil Kakodkar chairing the 93rd SAC meeting held through virtual conference on 30th March 2022. Seen in the picture Shri Sunil Kumar, Joint Secretary (Refineries), MoP&NG, Shri Alok Sharma, ED-CHT, and other esteemed members of the SAC along with special invitees.

Shri Alok Sharma, ED-CHT presented the terms of reference of the newly constituted Committee. Shri Sunil Kumar, JS(R), MoP&NG mentioned about the energy transition happening in the West vis-a-vis where we are. He sought the support of SAC in this regard. Chairman mentioned that we are passing through a very crucial phase of energy transition and challenges before India are probably very critical, more than any other country in the world, reason being we are fairly low in the development phase and we need to bridge the gap. He stated that we have to tune in the transition in a manner that is consistent with the resource profile.

Against the EOI dated 8th December 2021 for call of proposals under the specifically mentioned areas, 16 nos. of proposals were received for funding from CHT/OIDB. These proposals were reviewed by CHT Review Committee through virtual meetings on 21st, 22nd & 23rd February, 2022. The Principal Investigators of respective project proposals made virtual presentation on their proposals to the Committee. The Committee shortlisted 9 proposals for presenting before Scientific Advisory Committee (SAC) on Hydrocarbon of MoP&NG, for its recommendation for CHT/OIDB funding.

During the 93rd meeting, SAC deliberated on nine new proposals, submitted for funding by OIDB. One new R&D project proposal technically recommended in 91st SAC meeting was also deliberated. SAC also had detailed review of the on-going R&D and HCF projects. SAC recommended to form two separate committees for the path forward on R&D projects. Further, SAC recommended the closure of 2 R&D projects. SAC also noted the progress of 4 commercial and 1 demonstration projects under PM JI-VAN yojana.

Pre-bid Meeting regarding RFS issued under PM JI-VAN Yojana

Request for Selection (RFS) of Project Developers (PDs) for Commercial & Demonstration Scale 2G Integrated Bioethanol Projects was issued on 24th November 2021. In order to clarify queries of prospective bidders, a pre-bid meeting was held on 21st Dec'21 via video conference. CHT made a brief presentation on the

major features of the PM JI-VAN Yojana. Subsequently, participants raised their queries, which were clarified suitably by CHT team. Some queries raised during meeting required further consideration / deliberation by Competent Authority. The meeting was attended by 37 nos. participants.

Expert Group Meeting of R&D Projects

The Expert Group (EG) Review Meeting for the project "Scale-up studies and process development for H₂ production by Catalytic decomposition of Natural Gas" was held through Video Conference on 18th October 2021, under the Chairmanship of Prof. R. Kumar (Professor Emeritus, IISc). Shri P. Raman, ED (Acting In-Charge), CHT welcomed the Chairman and the participants and gave the brief background of the project. HPCL made a presentation on overall status of the project. HPCL mentioned that the current application of CNT is mainly in bullet proof jackets, medical applications, tyres etc. which is used in miniscule quantity. EG advised that

the project should be stopped at the lab scale in view of low demand of CNT however stated to keep the technology ready for future requirement.



Working Group Committee on Crude Selection and procurement

EC in its 31st Meeting advised CHT to carry out a separate meeting with stake holders to deliberate on issues in lining up consultant for studying the crude selection and procurement. A meeting was organized on 16th November 2021 under the Chairmanship of Shri Sunil Kumar, JS(R), MoP&NG and senior representatives from the industry. Accordingly, an inter refinery committee

was formed to review the existing crude selection and procurement procedure and suggest path forward to enhance flexibility and to make the system more agile in handling volatility and risk management. The Committee has submitted its draft report.

US-India-Energy Webinar on Transition to Clean Energy Technologies in Refining & Petrochemicals

In February 2018, USTDA hosted Indian delegation to US as part of RTM (Reverse Trade Missions) on Refineries Performance Optimisation. As follow up of this visit, after due approval by MoP&NG, an MoU was signed on 8th May, 2018 between American Chamber of Commerce in India (AMCHAM) and CHT on U.S.- India Collaboration in Refining and Petrochemical Industry. A meeting with US companies and Indian Oil PSUs senior officials was held on 4th February 2020 at Scope Complex New Delhi. In continuation of the above, the US-India-Energy webinar on 'Transition to Clean Energy Technologies in Refining & Petrochemicals India' has been jointly hosted by AMCHAM and CHT on 6th April' 2021.

The Webinar was attended by 120 participants including Senior officials from 35 US companies and Indian PSU Oil PSUs refineries, GAIL, IOC (R&D) and EIL. Following 7 companies made brief presentations which was followed by brief Q&A session.

1. Aquatech International
2. Black & Veatch
3. Bloom Energy
4. Dastur Energy
5. Gas Technology Institute (GTI)
6. NxtBrane
7. Trident Desalination Inc.

The Webinar ended with closing remarks and vote of thanks by Ms. Ranjana Khanna, Director General C.E.O., American Chamber of Commerce in India.

Working Group Meeting - "Revisiting Report on Enhancing Refining Capacity by 2040"

MoP&NG on 16th June 2021 has constituted a Working Group under the Chairmanship of Joint Secretary (Refinery), MoP&NG for revisiting the Report on Enhancing Refining Capacity by 2040, which was released by the Hon'ble Minister of Petroleum and Natural Gas in January, 2018. The Working Group will have a tenure of three months with following terms of reference;

1. To assess primary energy requirement for 2040
2. To assess likely technological development in different energy fields
3. To develop primary energy mix with break-up in terms of gas, oil, coal, nuclear, solar, hydro, hydrogen & biofuels etc.
4. To assess demand for major petroleum products

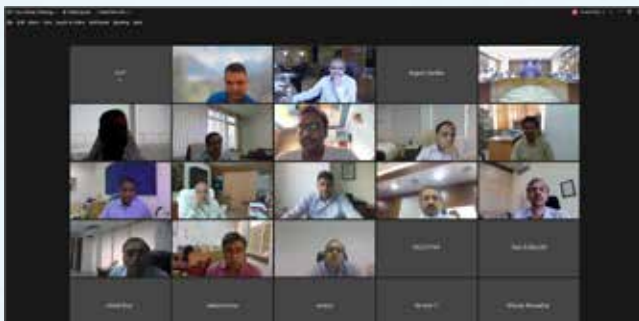
linking with advancements in use, substitution by other forms of energy, drive on enhancing energy efficiency and Government policies.

1st meeting of the Working Group was held through VC on 25th June 2021. Shri Sushil William, Dy Secretary, MoP&NG chaired the meeting.



Petroleum & Natural Gas – Research Collaboration Committee

Meeting of "Petroleum & Natural Gas – Research Collaboration Committee" was held under the Chairmanship of Dr. S.S.V. Ramakumar, Dir (R&D), IOCL on 11th August 2021 through video conference to overview R&D proposals of National Importance.



Shri P. Raman, ED-CHT (Acting-In-Charge) and Member Secretary of the Committee welcomed the Chairman, Committee members and the participants. During the last meeting of the Committee held on 17th June 2021, the Committee deliberated on 2 proposals. Rest 7 projects were reviewed on 11th August 2021.

Solomon Presentation on Pipeline Benchmarking 2020 Cycle

M/s Solomon Associates successfully completed the second cycle 2020 of Pipeline Benchmarking study during August 2021. M/s Solomon Associates made an Executive presentation of Study results on 04th August 2021.

Two days' Workshop - How to use Data online was also carried out on 9-10 August 2021. Study results have been shared with all the participating companies.

Shri Tarun Kapoor, Secretary, MoP&NG, chaired the online presentation of study results made by M/s Solomon Associates and senior officials of the participating companies of IOCL, HPCL, BPCL, OIL & GAIL on 16th September 2021.



Solomon Result Presentation on Refinery Benchmarking Study-2020 Cycle

Benchmarking of Indian PSU refineries was carried out successfully by M/s Solomon Associates and the Final Study Results for CY 2020 were submitted during October 2021. Given the extraordinary conditions due to Covid-19 during 2020, M/s Solomon has collected data for the entire year as well as during Covid-19 period (called proforma period) and provided the Benchmarking results. Online Corporate presentations were made to the top management of IOCL, BPCL and

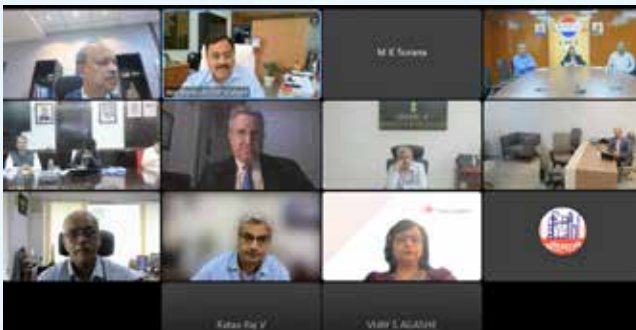
HPCL.

An online workshop on how to use data was conducted for all the participants from PSUs on 28-29 October, 2021.

Also, 6 Refinery Specific workshops (3 nos. each) for Steam Network, Size Reduction and Asset Lifecycle Management/Operational availability were completed as per the schedule.

Executive Summary Presentation to MoP&NG on Refinery Benchmarking Study Results by M/s Solomon Associates

M/s Solomon Associates presented the findings/ results of the Benchmarking study (CY2020) to the MoP&NG on 17th March 2022. The meeting was chaired by Shri Pankaj Jain, Secretary, MoP&NG and attended by the top management of Oil companies.



Shri Pankaj Jain enquired if the GC members were satisfied with the benchmarking process and whether it was helping the companies in evaluating their competitiveness and adding improvements. All PSU's expressed satisfaction with the benchmarking study and informed that they would continue the study to regularly assess the improvements in various KPI's.

“India accords topmost importance to the Oil and Gas sector. We are implementing pioneering reforms in the sector aimed at fulfilling our needs and at the same time working towards creating a sustainable planet.”

- Narendra Modi
Hon'ble Prime Minister of India



ACTIVITY COMMITTEE MEETING

2G Ethanol Technology and Project Execution

The 1st Activity Committee Meeting on “2G Ethanol Technology and Project Execution” was held on 17th May 2021 via Video conference. Shri K.K. Jain, ED-CHT welcomed the dignitaries Shri Sunil Kumar, JS (R), MoP&NG; Ms. Vartika Shukla, CMD EIL; Dr. S.S.V. Ramakumar, Dir (R&D), IOCL; and officers from oil industry. Ms. Vartika Shukla, delivered the theme address. She recalled that at the time of announcement of ethanol blending policy in 2015, the objective was to encourage quick commercialization of indigenous technology, particularly enzymatic hydrolysis of lingo-cellulosic biomass to 2G ethanol. She mentioned that since then and launch of PM JI-VAN Yojana in 2018, having an ACM on project implementation with all the stake holders for sharing challenges and successes of project implementation is a significant milestone for the nation. She underlined following efforts that Industry is taking to overcome challenges with the single objective to bring down CAPEX as well as OPEX:

- a) All technological pathways to enhance viability of the conversion of Biomass and not looking only at 2G ethanol.
- b) Ensuring cost effective feed stock supply chain with proper tie-up with suppliers
- c) Vendor development and strategy for fabrication (both site and shop), handing of engineered items even dovetailing changes by technology providers
- d) Indigenization of enzymes production

She wished that this ACM will result in flow of more innovative ideas and the cross sharing of knowledge will fast track these projects and make them more viable.

Dr. S.S.V. Rama kumar delivered the key note address. He mentioned that there is no previous experience or fall-back or benchmark available for the 2G ethanol technology. Two plants of IOCL and BPCL are in advanced stage, so it is very appropriate to learn from the hardship they faced and also through sharing of best practices, so that the same mistake won't be repeated. Presently, technology is at best TRL-5, he highlighted that following imperatives that need to be

addressed to make 2G pathways more successful and commercially viable:

- a) Biomass aggregation and supply chain management: Even if the technology is matured, if consistent quality and quantity of chosen biomass is not available, the whole CAPEX would become infructuous.
- b) Bring down OPEX by fine-tuning different technology steps of 2G ethanol viz. pre-treatment, hydrolysis followed by fermentation through intense research.
- c) Reduce consumption of chemicals (acids / bases) as their corrosive nature have direct bearing on CAPEX.
- d) Exploring / understanding pros and cons of steam explosion for pre-treatment step.
- e) Reduce Hydraulic Retention Time (HRT) or fermentation period from current 72 hrs or explore simultaneous hydrolysis and fermentation steps to reduce cycle time as well as turnaround times.
- f) Right kind of C5 selective yeast to improve fermentation efficiency and its indigenization.
- g) How to achieve global benchmark yield of 27%
- h) Life cycle emission in the reduction band of 65%
- i) Commercial viable pathways for lignin valorization viz. Vanillin, lactic acid, industrial silica, bio-plastic aggregates, etc.

He informed about innovative experimentation for biomass handling where-in pre-treatment of biomass was done at biomass generation site and the slurry was transported to 5 TPD bio-methanation plant at IOC R&D. This treatment has been done with simple machines and minimal CAPEX. Requisite quality of methane could be achieved by processing pre-treated slurry. This concept can be replicated in 2G Ethanol plants also, which can offer a key answer for formidable challenges of biomass aggregation and supply chain management.

He highlighted the advantage of producing enzyme at

site as it would not entail concentration, stabilization and its transportation of enzyme in cryogenic containers, which add to the costs. He also mentioned about another achievement regarding enzymes production by IOC R&D at 5 KL scale. Enzymes have been tested at M/s Praj pilot plant (12TPD) and its performance have been found on par with benchmark enzymes. He informed that the demonstration plant which is being put up by IOC R&D at Panipat, envisages on site production of enzyme and also simultaneous hydrolysis and fermentation steps.

He wished that this ACM will achieve its objectives of experience sharing and learning so that each one would be successful in achieving the objective of setting one showcase bio-refinery which will produce 2G ethanol and eventually spark the interest of Public- Private Partnership in this flagship campaign of enhancing ethanol production in the country.

Shri Sunil Kumar, JS(R), delivered the inaugural address. He mentioned that private parties have been very much intimidated by the cost, especially OPEX of the 2G plants.



The ideas put forth by Ms Vartika Shukla and Dr. Ramakumar would be very useful in mitigating some of the issues related to biomass storage and supply chain and towards viability of these projects.

He informed that amendments in PM JI-VAN Yojana will be put up to the Cabinet for approval within 2-3 weeks' time. There was lot of feedback from existing sugar companies or companies who want to buy those sugar companies or distilleries to make 2G ethanol. By allowing bolt-on as well as brownfield projects, the purpose is to reduce CAPEX. This gives them a cushion to get a loan from a bank. VGF, besides the financial

support, also provides assurance that government is behind these projects. He hoped that with modified scheme, more and more proposals will come from private parties also and that will create a more competitive environment, as competition generates a lot of ideas.

He invited ideas / discussions to make technology feedstock agnostic so that this can be replicated. He advised to think about standardization and modularization so that these can be replicated elsewhere very easily with minimal cost. He mentioned that Govt. has been very persistent on 2G despite lukewarm response worldwide. After initial euphoria, many countries had left it while some countries have few projects, but India has gone persistent. He believed that India will be a leader in this technology and going to be successful in 3 to 4 years. This COVID has shown one thing that globalization, with some percent of localization is very important and localization of energy is going to happen in the form of bio refineries.

He hoped that ideas would emerge through experience sharing that will help in reducing cost of 2G ethanol technology. And if any feedback or narrative comes about the Policy Changes, Ministry is very open and flexible to assimilate the same.

Thereafter, IOCL, BPCL, HPCL, ABRPL, IOC R&D and EIL shared their experience on project execution strategies, equipment procurement, challenges faced in biomass supply chain management, support needed to expedite the completion, etc.

Shri M.S. Patke, ED (Biofuels), BPCL and Convener of the ACM summarized the key takeaways as under;

- i. Biomass Standardization and Storage: IOCL & BPCL should work jointly to optimize it.
- ii. Separate discussion may be held by IOCL and HPCL on Utility consumption at their respective units.
- iii. Ash, mud & sludge disposal: 140 TPD of ash/ mud disposal for a 100 KLPD plant will be a huge problem. Apart from storage problem, ash will create environment problem also. It is problem area for all companies and there is no readymade solution. As the same licensor is there for IOCL, HPCL & BPCL, quality of ash will be quite similar (rice straw source could be different). If some



- breakthrough is made with fertilizer or brick manufacturing company, it should be shared with each other.
- iv. Manpower requirement: It is now estimated to be more than the initial projections made by M/s Praj. There is a need to carry out deep scrutiny and optimize manpower as it is going to be a big cost element.
- v. Integration of 1G and 2G ethanol plant: It is a cost advantageous approach. More discussion is required regarding facilities and utilities sharing.
- vi. Vendor development for various equipment: This can bring down CAPEX and may be OPEX in future.
- vii. Production of Bio-chemicals: In case of ABRPL, in spite of CAPEX going up, IRR is still favourable due to forward integration with bio-chemicals, like furfural, acetic acid, etc. This is worth emulating by all the oil companies. R&Ds also need to work on it in parallel, so that in future 2G ethanol projects can become economically viable.
- viii. Enzymes and Yeast: IOC R&D has done a lot of work, and should support other companies and take a lead in this particular area. Not only localized production but also in-situ production will greatly reduce the OPEX. In this area IOCL, BPCL & HPCL need to work together.
- ix. Lignin Valorization Needs thrust. If lignin can be put to better use and value-added products are developed, it will definitely improve profitability of the projects.
- x. Pandemic effect: Need to vaccinate all labourers for meeting the timelines of project execution.
- xi. Process optimization: IOC R&D's efforts for Innovations in Pre-treatment step and Integration of hydrolysis and fermentation into single step needs to be closely followed up by all.
- xii. Gasification technology being explored/implemented at MRPL: The process is feedstock agnostic and even can take MSW. The chemical and utilities consumption is lower. CAPEX is also projected to be relatively low as compared to enzymatic hydrolysis. The technology potentially may be path breaking.
- xiii. Role of EIL: EIL need to develop the optimized template for 2G ethanol technology and develop new benchmarks, so that 3-4 years down the line, if somebody really wants to get into 2G ethanol they would have a readymade template for that.
- He also suggested to have separate detailed discussion on topics like on-site enzymes production, biomass aggregation, bio-chemicals, etc.
- 60 nos. of officers from IOCL, BPCL, HPCL, MRPL, NRL and EIL participated in the ACM.

Fuel & Loss and Energy Optimization

ACM on "Fuel & Loss and Energy Optimization" was conducted virtually on 18th November 2021 with BPCL-KR as host refinery. The ACM was attended by 90 delegates across refineries with 10 presentations. Industry has rightly embraced digitalization with real time monitoring and use of advanced control systems. Honourable Prime Minister of India, Shri Narendra Modi recently announced that India will be Net neutral by 2070. Along with efficiency and effectiveness, the industry proactively seeks sustainable growth, therefore we need to actively look upon opportunities towards minimizing environmental footprint. Some of the key take away from the presentations include:

- Hydrogen management by IOCL Panipat
- Heat transfer efficiency improvement or exchanger

fouling detection TACIT system by IOCL Paradip

- Loss management especially custody transfer loss mitigation by DBBA - Double block and bleed system by HPCL MR and IIOT based flare flow analyzers
- Conversion from steam drives and steam tracing to electrical by BPCL MR, Hot oil system by BPCL Kochi
- Crude analyzers by Nayara Energy Limited
- GT Dry ice blasting by MRPL
- IOCL Mathura's path of Green Hydrogen plant and green energy was much appreciated and is the worth emulating

Rotary Equipment

A one-day virtual Activity Committee Meeting on Rotary Equipment was held on 17th December 2021 in association with HPCL, Mumbai Refinery. Shri Libu Verghese Mathew, CGM (Maint.) HPCL, MR, welcomed all the dignitaries and participants. Chief Guest Shri Alok Sharma, ED-CHT delivered the Theme Address where he highlighted the importance of sharing our knowledge, experience and best practices and how CHT was aiding in bridging gaps between the various refineries. Chief Guest Shri A.B. Chattopadhyay, CGM(T) - ED(I/C), HPCL, MR gave the Inaugural Address. Shri Arijit Sanyal, Chief Manager, Rotary, Maintenance



department was the convener of the meet. A total of more than 120 delegates from IOCL (Ref. / PL / RHQ (M&I), BPCL KR/MR, HPCL-MR/VR, GAIL, CPCL, HMEL, NRL, NEL, MRPL, EIL, OISD & Vendors i.e. M/s Sulzer Pumps, Switzerland, M/s Triveni Engineering India Ltd. & M/s Hoerbiger India Pvt. Ltd., participated. In all 15 refineries and 3 OEMs show-cased their presentations.

All the participants shared their case studies, learnings, initiatives in the field of maintenance and digitalization and best practices adopted. Each presentation was followed by short Q&A session. WhatsApp group was formed, comprising of all the participants and the chat box was enabled, to encourage participants to post their queries online.

Post completion of all the presentations, the key takeaways were summarized by Shri Udoay Payyadi, DGM Rotary, Maintenance department. The valedictory session witnessed Shri Libu Verghese Mathew, CGM (Maint.) HPCL, MR and Shri P. Raman, Director, CHT stressing on the importance of the meet with insights regarding the way forward, which was followed by Vote of Thanks.

Environment and Water Management

ACM on Environment and Water management was held on 25th January 2022 in association with MRPL. Shri M. Elango, ED, MRPL (Refinery) was the Chief Guest for the meet. A total of 110 delegates participated in the ACM and sixteen presentations on various aspects of water and environment management were made by IOCL, BPCL, HPCL, CPCL, MRPL, NRL, NayaraEnergy. The presentations were also there from HPCL R&D and BPCL R&D SBU too along with vendors i.e. EKI Energy Services Ltd., UOP, VA Tech Wabag Ltd. & EIL.

Refineries presented on key initiatives undertaken and

case studies on ETP management, ZLD, SRU outages, handling public complaints, development of green hydrogen, case of high conductivity in treated effluents, sludge handling, on illuminating flare, trouble shooting of excessive foaming in amine absorbers, road map for net zero emissions and trouble-shooting of high-pressure drop-in RO. HPCL and BPCL R&D presented on improving effluent quality on addition of bio additive, HP Gelators and HP SOS - a potential solution for oil spillage and recovery, vapour recovery system for petrol station (From concept to Commercialization).

Hydroprocessing & Hydrogen Generation

ACM on Hydroprocessing & Hydrogen Generation was conducted virtually on 25th Feb'2022 in co-ordination with IOCL -Mathura Refinery. Shri Alok Sharma, ED-CHT presented the theme address and Shri A.K. Maiti – Executive Director & Refinery Head, IOCL-MR delivered the inaugural address. Shri Rahul Srivastava, DGM (TS), IOCL-MR welcomed all the dignitaries and participants. Approx. 125 delegates from refineries of IOCL, BPCL, HPCL, MRPL, CPCL, BOREL, NRL, Nayara Energy; R&D centres of IOCL, BPCL & HPCL; CSIR-IIP; EIL and private companies viz. Axens, Haldor Topsoe, & Honeywell-UOP participated in the ACM.





Hydroprocessing has assumed lot of importance in view of the stringent quality specifications under BS-VI. For Hydrocrackers and Hydroprocessing units to run uninterrupted, it is imperative that HGUs run smoothly. So HGU along with Hydroprocessing has been included from 2019 onwards. Govt. of India has announced "Green Hydrogen Policy" recently on 17th February 2022, focusing on India as Green Hydrogen Hub and exporter of Green hydrogen. Aply, for this ACM, Green Hydrogen technology implementation

plan in the refineries was also included.

A total of 17 presentations (3 from PSU R&D Centres, 3 from Technology Licensors, 1 from EIL & 10 from PSU Refineries) were made during the ACM. All the presenters / speakers shared their case studies, learnings, initiatives & new developed technology in the area of Hydroprocessing & Hydrogen Generation and best practices adopted. Post completion of all the presentations, the key takeaways were summarized by ACM Convener followed by vote of thanks.

Processing of Proposals of Oil PSUs seeking relaxation for Global Tender Enquiry (GTE) for Tenders below Rs. 200 Crore

In order to Promote Self-reliance, make in India and to promote Micro, Small, and Medium Enterprises (MSMEs), amendments were made in rule 161 (IV) of General financial Rules (GFR) vide OM F.No 12/17/2019-PPD dated 15th May 2020, mandating that no Global Tender Enquiry (GTE) shall be invited up to Rs. 200 Crores or such limit as may be prescribed by department of Expenditure from time to time. Subsequently there were relaxation to Rule 161 (IV) (b) of GFR vide OM No F. 20/43/2020-PPD dated 21st December 2020 & OM No F. 20/44/2020-PPD dated 24th December 2020 for procurement of various items for two years which were critical for operation and expansion of Oil and gas PSUs for Global Tender Enquiry (GTE).

CHT has been made nodal agency to examine and technically recommend GTE proposals pertaining to Downstream and Midstream sector to administrative division of the Ministry for further processing. The

proposals have been qualified under three categories:

1. Proposals pertaining to exempted items covered under OM dated 21.12.2020
2. Proposals pertaining to Licensor Mandated items from foreign vendors OM dated 24.12.2020
3. Proposals not covered under exempted items and Licensor Mandated items from foreign vendors

Procurement of spare parts of equipment/Plant & Machinery etc. on nomination basis from OEM/OES or OPM are exempted from GTE approval process.

A total of 414 / 419 proposals were processed by CHT, received from various OPSUs i.e. M/s IOCL, BPCL, MRPL, CPCL, HPCL, NRL, GAIL, BCPL for seeking relaxation for GTE for tender below 200 Cr., till the month of March 2022. 5 nos. proposals are pending for clarification from PSUs.

Integrated Monitoring and Advisory Council (IMAC)

The report of the Working Group on R&D and Innovation constituted under Integrated Monitoring and Advisory Council (IMAC) was reviewed by Shri Tarun Kapoor, Secretary, MoP&NG on 17th August

2021. M/s Shri P. Raman, ED-CHT (Acting In-charge), made the presentation. PPAC has been advised to consolidate reports of all the Working Groups. PPAC has appointed PwC as consultant for the same.

Meeting with M/s Clariant: Presentation on 2G Ethanol Technology

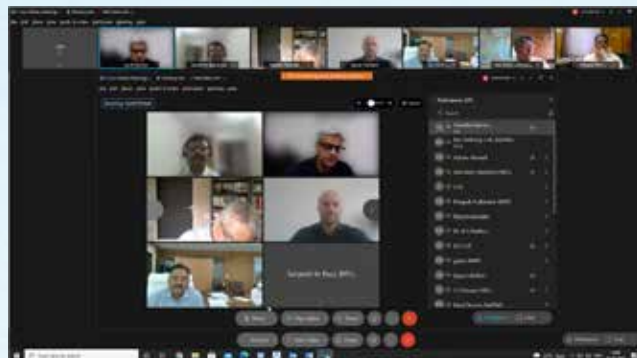
Meeting was convened by MoP&NG with M/s Clariant under the Chairmanship of Shri Sunil Kumar, JS (R), MoP&NG on 20th July 2021 through Video Conference. The meeting was attended by senior officials from O&G PSUs dealing with biofuels. Presentation by M/s Clariant included the following: Sunliquid® technology (Fully integrated process) for efficiently converting

agriculture residue (Lignocellulosic biomass) into bioethanol; Status of 50 KTPA 2G ethanol commercial plant in Romania; Learnings on the feedstock supply chain management for the above-mentioned project; Opportunities for 2G ethanol projects in India.

Meeting with M/s ENI (Italy)

A Meeting was convened by Invest India with M/sENI (Italy) on 20th July 2021 through Video Conference. Presentation by M/s ENI included the following:

- ENI Slurry technology (scaling up success: from Lab to 9.9 MMTPA Installed);
- ECOFINING™: High quality hydrocarbon biofuels production;
- PROESA® technology: a platform for 2G Ethanol projects and bio-refineries (commercial scale plant in Cresentino);
- ENI Research and Technological Innovations.



New Energy and Industrial Technology Development Organization (NEDO) India hosted “India – Japan Hydrogen Seminar”

To commemorate the 70th Anniversary of the establishment of diplomatic relations between Japan and India, NEDO India under the Ministry of Economy Trade and Industry Japan hosted the India – Japan Hydrogen Seminar on 24th March 2022 in New Delhi.

In collaboration with TERI, the session addressed the enormous potential of hydrogen in India which will

attract Japanese industries with advanced hydrogen technologies. The focus was on understanding the supply side. (e.g., competitive cost of hydrogen) and the demand side. (e.g., how much hydrogen will be used in Oil Refinery, Chemical, Steel, Power, Mobility industries).



The seminar was one of a series of events during “India-Japan Hydrogen Month”. During the Seminar, Shri Alok Sharma, ED-CHT presented a paper and remarked that the “The paradigm shift in the energy landscape is becoming clearer day by day with falling prices of Renewables. Hydrogen is emerging at the heart of decarbonization and is full of Opportunities.”

Eiji Ohira, DG, NEDO, said “Hydrogen is a key technology for carbon-neutral and Japan has been strongly promoting hydrogen and has just started market penetration, therefore, there is a need to enhance the application, improve technology. The goal is to develop a low-carbon energy system and scaling-



up/integration with another energy system.

Yoshiro Kaku, Chief Representative, NEDO India said Japan’s public and private sectors have long been engaged in hydrogen. NEDO also has been developing hydrogen energy technology almost since its establishment, with a history of around 40 years.

As a result of such efforts, Japan has developed various advanced hydrogen technologies, such as stationary fuel cells, FCVs, electrolyzers, hydrogen transport systems, hydrogen utilization in power plants and steel plants. Japan has world-leading hydrogen and ammonia technologies, and India has the world’s highest-level hydrogen potential.



CHT Focuses on Collaboration with Global Labs

In view of change in energy landscape, Govt's focus on clean energy transition and energy independence, CHT has initiated interactions with following foreign labs, working in different areas of energy, for prospective collaborations:

1. National Renewable Energy Laboratory (NREL), USA
2. Energy & Environmental Research Center (EERC), University of North Dakota

3. New Energy and Industrial Technology Development Organization (NEDO), Japan

Focus will be more on Hydrogen, Gasification, Biofuels and CO₂ capture & its conversion. One round of discussions has been held and as a path forward, few projects will be identified for joint R&D with Oil & Gas companies, knowledge sharing and technology demonstration and commercialization in India.

Petrochemical Benchmarking

In line with refinery benchmarking studies, CHT is in the process of carrying out benchmarking of major petrochemical units of PSU's. A Committee comprising PSU representatives was formed to finalize the Terms of Reference (TOR) of EOI to identify potential consultants.

Draft EOI has been prepared. EOI shall be floated in April 2022 and the percentage reimbursement on the base fees for the participating companies in line with Refinery Benchmarking Study shall be deliberated in EC.

CHT Webinar Series

As a part of new initiatives, CHT has commenced Webinar series on the new focus areas which are very pertinent to the Hydrocarbon Industry. The Webinars organized in this quarter were on the following topics:

1. Crude to Chemicals
2. Electrolyzers
3. Bio-fuels

The duration of each Webinar was kept as 2/3 hours. The Webinar series was conducted by various experts of the Industry & Academia. These webinars shall result in bring good opportunities for sharing & networking and discussing new insights.

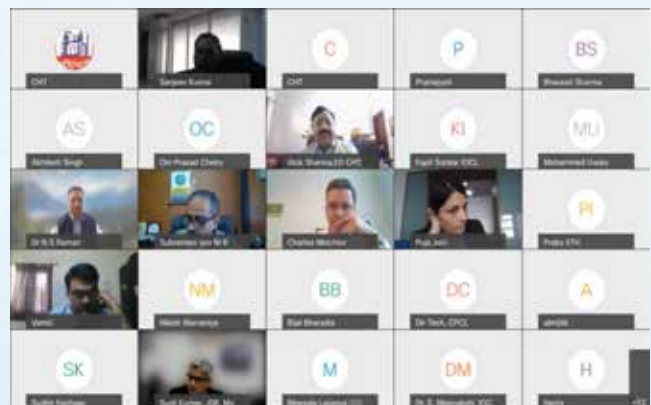
A) Crude to Chemicals

Online Webinar on Crude to Chemicals was organized on 18th January 2022. Shri Sunil Kumar, JS (R), MoP&NG, delivered the inaugural address and Shri Alok Sharma, ED-CHT presented the welcome address. Speakers from five organizations viz. M/s KBR Technologies, M/s Honeywell UOP, M/s CLG (Chevron Lummus Global) & M/s Axens, gave presentations on their various technologies developed. The technology selection mainly depends on the key factors such as business strategy, increased petrochemicals demand, infrastructure, economics, reduction in carbon

footprint, process fuel on demand etc.

B) Electrolyzers

Online Webinar on Electrolyzers was organized on 8th February 2022. Dr. N.S Raman, Director, CHT welcomed all the dignitaries and participants. Shri Sunil Kumar, JS (R), MoP&NG, delivered the inaugural address and Shri Alok Sharma, ED-CHT presented the welcome address. Speakers from five organizations viz. M/s McKinsey, M/s Thyssenkrupp, M/s Ohmium, M/s FEST, & M/s Halder Topsoe gave presentations on the latest developments in the area of Electrolyzers.



C) Webinar by M/s KBR on Gasoline Mximization (MAX - ISOM™) and Solid Acid Alkylation Technology (K - SAAT™)

A webinar was arranged by CHT on 9th February 2022 on KBR’s futuristic solutions for Gasoline blend components and their suitability for the Indian Gasoline blending scenario. Recent developments with Ethanol blending in Gasoline open further opportunities for refineries in widening their blending baskets.

D) Biofuels

Webinar on Biofuels was organized on 4th March 2022. Dr. N.S Raman, Director, CHT welcomed all the dignitaries and participants. Shri Alok Sharma, ED-CHT delivered the welcome address and Smt. Vartika Shukla, CMD, EIL, presented the inaugural address. Speakers from M/s LanzaTech, M/s Praj Matrix- R&D center, M/s Axens, M/s Fortum India, & M/s Clariant

gave presentations on the latest developments in the area of Biofuels.



Smt. Vartika Shukla, CMD, EIL presenting the Inaugural address during online CHT webinar on Bio-fuels on 4th March 2022.

CHT Meeting with M/s Honeywell UOP

CHT interacted with M/s Honeywell UOP on 23rd March 2022 for discussions on how Honeywell can work with the MoP&NG goals regarding the country’s sustainability commitments and work towards technologies solution provider for achieving Net Zero. The key areas where UOP has successfully developed

innovative technologies is based on Industry needs which include Green Hydrogen, Blue Hydrogen, CCUS (Carbon Capture Utilisation and Sequestration), Refining, Petrochemicals, Gas Processing, Energy Storage, Plastics recycling, Catalysts, Adsorbents etc.

CHT Meeting with M/s Fortum Oyj, Finland

Ms. Heli Antila, Vice President, Bio-based solution Fortum Oyj, Finland visited CHT office on 21st March 2022. She interacted with Shri Alok Sharma, ED-CHT; Dr. N.S. Raman, Director, CHT and other senior CHT officials. During the meeting, she apprised CHT about the Fortum’s goal towards securing a fast and reliable transition to a carbon-neutral economy by providing customers and societies with clean energy and sustainable solutions. She also apprised CHT on the latest developments in the Bio-fuel manufacturing including value addition to many of the by-products produced in the 2G ethanol plants.



Shri Alok Sharma, ED-CHT (standing 3rd from left) interacted with Ms. Heli Antila, Vice President, Bio-based solution Fortum Oyj, Finland & her team at CHT office on 21st March 2022. Also seen in the pic are Dr. N.S. Raman, Director, CHT (second from left) & Shri S.K. Varshney, Joint Director, CHT.



CHT Meeting with M/s Praj Industries

Dr. Pramod Chaudhari, Chairman, Praj Industries visited CHT office on 21st February 2022 to apprise regarding the new developments in M/s Praj Industries with respect to Bio-ethanol production including lignin valorization. On this occasion, Shri Alok Sharma, ED-CHT honoured Dr. Pramod Chaudhari, for being the recipient of the Lifetime Achievement Award from the prestigious Holmberg Award at Washington D.C., U.S.A.



Shri Alok Sharma, ED-CHT interacted with Dr. Pramod Chaudhari, Chairman, Praj Industries at CHT office on 21st February 2022.

Saksham-2022

CHT organizes Furnace efficiency survey and STEAM leak survey (Saksham) across all refineries in alternate years. As part of Saksham 2022, steam leak survey has been carried out at all the Indian Refineries (except RIL) in two phases during 14-16th March and 21st-24th March 2022. The steam audit survey was conducted by teams

which will have three to five members including the team leader cum coordinator from the same Refinery and two to four external members from the Refinery/CHT. The Saksham Awards-2022 shall be presented in the upcoming ETM.

Digitalization in CHT

A digital workplace solution comprising of a suite of products has been developed by NIC. The vision of e-Office is to achieve a simplified, responsive, effective and transparent working of all Government Offices. It aims to transform the Government work culture and ethics. The product is built on Open Architecture that paves the way for an efficient and open government by streamlining workflow for both inter and intra government processes and making them paperless.

The implementation of e-office in CHT, PCRA and OIDB was approved by EC of CHT under the Chairmanship of Shri Sunil Kumar, JS (R), MoP&NG and its implementation was coordinated successfully by CHT. The joint implementation has resulted in saving of

capital expenditure to the tune of Rs. 4.5 crore. CHT has been awarded as India's first organization running e-office version 7.1.1 in the country.

In addition, following process have been fully digitalized;

- Organization of Activity committee and Technology Meets has been digitalized including submission of abstracts and full papers, Registration, Online invoicing and all payments for better control and focus on event using technological enhancement by using QR code on unified platform.
- Online process for collecting data from Oil Refineries/Companies
- PM JI-VAN YOJANA Dashboard

Repurposing Natural Gas Pipeline for Transportation of Hydrogen Natural Gas Blend



Shri Alok Sharma
Executive Director



Dr. S.S. Gupta
Advisor (Tech.)

Adding hydrogen to natural gas can significantly reduce greenhouse gas emissions if the hydrogen is produced from low-carbon energy sources such as biomass, solar, wind, nuclear, or fossil resources with carbon capture and storage (CCS). One of the key elements of decarbonization is use of Hydrogen in various segments, viz. transport, Industry, residential, power plants, Steel Plants Refinery etc. Therefore, distribution infrastructure of Hydrogen across the nation from the production Centre to the consumers is an important link in the chain.

In India industrial facilities like power plants, steel plants, refineries are distributed across the nation, therefore, to achieve the decarbonization goal, transporting of Hydrogen through the cross-country pipelines cannot be avoided.

There are nearly 4500km of dedicated hydrogen pipelines in the USA and Germany that are in operations for more than a decade without much problem. However, laying of dedicated hydrogen pipeline is not only prohibitively expensive but also a time-consuming process (a pipeline may require more than 4 years to become operational, i.e., from concept to commissioning).

Table 1: Comparison of Cost, Repurpose vs. New Pipeline

Pipeline Diameter	Repurpose / New	Design Capacity	Inlet pressure	Operating pressure	Pipeline Capex	Compression Capex
Mm/inch	-	GW H2(LHV)	bar	bar	M €/km	M €/km
1200/48	Repurposed	13	40	80	0.5	0.62
	New	13			2.8	0.62
900/36	Repurposed	36	30	30	0.4	0.14
	New	47			2.2	0.32
500/20	Repurposed	12			0.3	0.09
	New	12			1.5	0.09

Source: Extending the European Hydrogen Backbone, A EUROPEAN HYDROGEN INFRASTRUCTURE VISION COVERING 21 COUNTRIES, APRIL 2021

One of the options to overcome this challenge is to transport hydrogen through existing natural gas pipeline in blends of H₂:CH₄ at predetermined fractions. Various studies have indicated that the cost of repurposing an existing natural gas pipeline for transportation of H₂:CH₄ blend works out to 15 to 20% of what it takes to lay a new dedicated Hydrogen pipeline. However, this option too has its own technical challenges, Hydrogen Embrittlement (HE) of steel is a serious challenge to the integrity of pipeline material, current state of knowledge indicates that higher the percentage of hydrogen in the blend and higher the operating pressure in a pipeline, more is the possibility

of hydrogen damage. Hydrogen ingress in the steel matrix may causes severe degradation of mechanical properties like ductility and fracture toughness, increase the Fatigue Crack Growth Rate (FCGR) thereby making the pipeline vulnerable to rupture. Research on feasibility of transportation of hydrogen blends through existing natural gas pipelines in India merits serious consideration.

The primary technical challenges that can be faced while repurposing a natural gas pipeline for transporting blends of H₂:NG can be many, a few critical ones are listed below:



a) Steel Compatibility: Hydrogen attack on API grade line pipe steel has been a matter of concern. The current level of knowledge on Hydrogen Embrittlement indicate that hydrogen atoms can get lodged into the steel matrix (both in the lattice and the grain boundary). It is further reported that hydrogen concentration could be higher at the preexisting anomalies in a pipeline e.g., existing cracks or corrosion or hard spot etc. Due to presence of Hydrogen atoms inside the steel the mechanical properties especially ductility, fracture toughness is adversely affected, the stress intensity factor also becomes higher and fatigue crack growth rate increase. It is further seen that with higher percentage of hydrogen in a blend and at higher operating stress level of the pipeline, the vulnerability to failure of pipeline increases (2). Therefore, the line pipe metallurgy of natural gas pipeline identified to transport H₂:NG blends shall have to be evaluated thoroughly for above aspects. The physical H₂ readiness of the natural gas system essentially depends on the possible influence of hydrogen on the materials used. Especially for line pipes and fittings made of steel, a reduction in material toughness can be measured under the influence of hydrogen ('hydrogen embrittlement'). Depending on the steel grade and the operating conditions of the pipeline, this reduction in toughness can lead to the growth of existing crack-like defects. In these cases, the service life of the line is therefore reduced. According to current knowledge, the following factors are essential: existing crack-like defects, especially on the inside of the pipeline. One way to reduce the severity of the hydrogen damage on a pipeline is to use pipeline grade up to API 5L X-52, however, majority of Indian gas pipelines are made of X-70 pipes (therefore, more vulnerable to hydrogen damage at least theoretically), alternatively, a natural gas pipeline repurposed to transport H₂-CH₄ blend shall have to be operated at a Specified Minimum Yield Stress (SMYS) of 40% (4). Reduction in stress level would mean operating the pipeline at a lower throughput level, which may not be a preferred option to the pipeline operator.

b) Suitability of Compressors to pump H₂ : CH₄ blend

Suitability of the existing pumping system viz, compressors to handle blends of H₂ : CH₄. As hydrogen is nearly 9 times lighter than natural

gas, not only extra compression power would be required to deliver equivalent quantity (of Natural gas) at the delivery end, but also the suitability of the existing location of the compressor stations needs to be established, as hydrogen natural gas blend would travel much faster (with less loss of pressure) and may reach the downstream station at higher pressure. Further, However, energy capacity per volume of hydrogen is much lower than the natural gas. When hydrogen is injected, transported volumes should be increased to keep the same available energy capacity at the pipeline output. In such case, it has been observed that existing compressor station can cope with hydrogen content up to 5% volume, using speed and power design margins. Above, compression equipment should be replaced [Blending hydrogen into existing gas grid: opportunities and challenges for pipeline e-motor compressor system design, Thomas ALBAN, Baker Hughes / Thermodyn, France. Pipeline Technology Conference 2020, Berlin]

When Hydrogen is injected in a pipeline section, with assumed content of 10% and 20%. The thermodynamic properties of the resulting gas mixture, including specific gravity, energy density and compressibility factor, undergoes considerable change (refer table 2)

Table 2: Thermodynamic properties of different Methane and Hydrogen mixtures

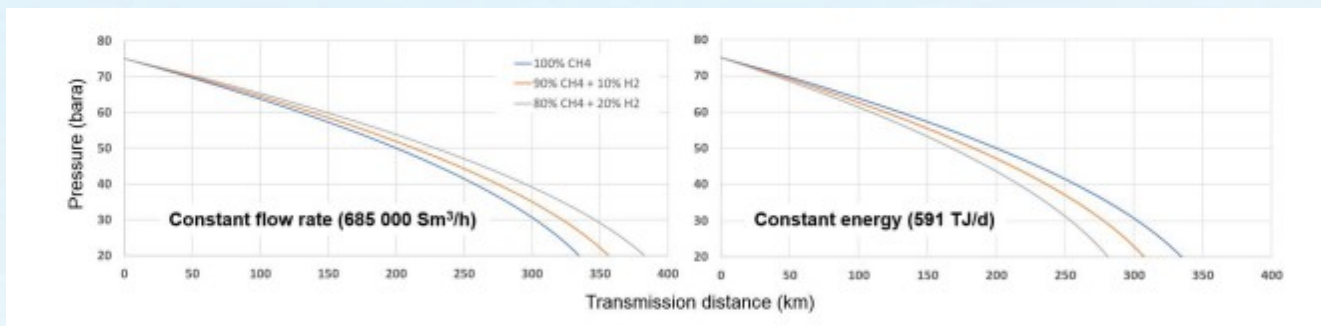
Parameter	Unit		90 CH ₄ + 10H ₂	80 CH ₄ + 20H ₂	
Molecular weight	gm/mol	16.04	14.64	13.23	2.016
Specific Gravity @ 1bar/ 15 deg.C	-	0.67	0.61	0.55	0.07
Energy density per volume	MJ/Sm ³	35.9	33.2	30.5	9.05
Compressibility factor at Pipeline condition	-	0.9	0.9225	0.947	1.135

Source: Blending hydrogen into existing gas grid: opportunities and challenges for pipeline e-motor compressor system design, Thomas ALBAN, Baker Hughes / Thermodyn, France. Pipeline Technology Conference 2020, Berlin.

As compressibility and specific density are input parameters in Panhandle equation (Panhandle equation is a simplified formula to calculate gas flows in large and long pipeline sections), the operating conditions of the pipeline section are affected by the new

mixture that is transported. The figure below reports the pressure evolution along the pipeline versus the travelled distance for three different gas compositions (100% CH₄, 90% CH₄+ 10% H₂, 80% CH₄ + 20% H₂) and considering 2 operating philosophies.

Fig 1: Pressure evolution versus H2 fraction, for constant gas flow rate or constant energy



Source: Blending hydrogen into existing gas grid: opportunities and challenges for pipeline e-motor compressor system design, Thomas ALBAN, Baker Hughes / Thermodyn, France. Pipeline Technology Conference 2020, Berlin

The first case reported in fig. 1 considers a constant gas flow at the output of the pipeline. In such case, we can notice that the injection of hydrogen in the network reduces the friction losses, mainly because the new gas mixture is lighter. After 200 km, the pressure has only dropped from 75 bar to 53,8 bar for 20% hydrogen blending while the value has dropped to 50 bar with pure methane.

As indicated in Table 2, the higher is hydrogen content in the gas mixture, the lower is the energy density per volume unit at standard conditions. Indeed, the combustion of 1 cubic meter of methane at standard conditions releases 35,9 MJ while the combustion of the same volume of pure hydrogen releases almost four times less (9 MJ.) The pipeline operator may want to maintain the energy capacity of the transportation system as the end user pays for a certain energy consumption. To compensate for the reduction in volumetric energy density, the volume flow transported in the pipeline must be increased proportionally. The second case reported in fig. 1 considers now a constant energy capacity of 591 TJ/day. Now it can be noted that with this new assumption, the situation is completely reversed. The mixture with the highest hydrogen content now generates more friction losses. For a transportation distance of 200 km, the pressure losses have increased by about 25% to 30%.

The question for the pipeline operator is to decide whether to deliver at same flow (as previously done with pure CH₄) or same energy content (higher compressibility). The suitability of the compressor would depend upon above decision. As existing compressor stations have been designed for the operational case with methane, one needs to evaluate the suitability of existing installation for operation with hydrogen blending.

c) Suitability of Equipment e.g., valves, measuring devices etc.: Hydrogen damage is one of the concerns for many metallic piping materials. The occurrence and the severity of hydrogen damage on metallic materials depend on the type of materials, hydrogen concentration and the operating parameters. It is important to understand the acceptable hydrogen level that can be blended into natural gas without adversely impacting the life of the component (5). Since hydrogen is the smallest element, it has a greater tendency than natural gas to leak through valves, seals, gaskets and pipes. Gas meters record the volumetric quantities of the gas supplied. Adding hydrogen into natural gas changes the gas properties. Therefore, it is necessary to quantify the deviation of the gas meter when measuring hydrogen/natural gas mixtures at various hydrogen levels.



It would be necessary to develop a specialized integrity management programme for the pipeline that is repurposed/ to be repurposed to ensure efficiency of operation of valves, other fittings including measuring devices. Such a programme shall ensure that hydrogen leakage / hydrogen concentration is monitored on 24 x 7 basis.

- d) **Hydrogen Safety:** The flammability range (LEL to HEL) for hydrogen is much wide than CH₄ (Natural gas), therefore, risk of explosion from H₂ release (from pipelines) is more, however, H₂ being lighter than CH₄ disperses more quickly into the atmosphere. Due to this property of H₂, less area is likely to be impacted due to uncontrolled release of H₂ -blend from pipeline compared to the release of pure natural gas. On the other hand, in a confined space accumulated H₂ (from leaks etc) is more likely to be a cause explosion compared to natural gas. Besides hydrogen being colourless and odourless, makes it more of a candidate than natural gas to cause accident. Due to this behaviour

of H₂/ H₂:NG blend and corresponding safety issues, safety guidelines shall have to be revised along with the Emergency handling procedure of a pipeline

Reference:

- 1) Extending the European Hydrogen Backbone, A EUROPEAN HYDROGEN INFRASTRUCTURE VISION COVERING 21 COUNTRIES, APRIL 2021
- 2) Somerday, B.P. Technical Reference on Hydrogen Compatibility, Sandia National Laboratories, Livermore CA, USA
- 3) Extending the European Hydrogen Backbone, A EUROPEAN HYDROGEN INFRASTRUCTURE VISION COVERING 21 COUNTRIES, APRIL 2021
- 4) ASME B.31.12-2019, "Hydrogen Pipeline and Piping."
- 5) M. W. Melaina, O. Antonia, and M. Penev, Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues, National Renewable Energy Laboratory, USA

75th Independence Day Celebrations at CHT

Shri P. Raman, ED-CHT (Acting In-Charge), hoisted the flag on the occasion of 75th Independence Day in the premises of CHT office and extended his best wishes to all the officers.



33rd Foundation day of CHT Celebrations

In pursuit towards the objectives of CHT for informations sharing, a technical workshop on 'Energy Transition' was organized on 24th August 2021, on the 33rd Foundation Day of CHT. Dr. S.J. Chopra, Former ED-CHT was invited as the Chief Guest. Shri P. Raman, ED-CHT (Acting In-charge) welcomed Dr. S.J. Chopra on this occasion. The workshop was inaugurated by Dr. S.J. Chopra.

Dr. S.J. Chopra shared the experience of his tenure with the officials of CHT. During the workshop, the in-house faculty apprised the officials about the new practices to be adopted at the workplace in the 'Energy Transition'. During the workshop, Shri Amal Kumar Roy, Advisor (Technical) presented details on functions of CHT. Shri Satya Prakash, Advisor (Technical) presented on the energy sector scenario in 2040. Shri Brijesh Kumar, Advisor (Technical) gave detailed information about 'Energy Transition' in future. The challenges of maintaining market share and in business processes

were discussed during the workshop. Major future opportunities exist the area of the renewables, biofuels and petrochemicals, Adoption of automation and digitalization in business processes, artificial intelligence, new and clean technologies in the oil and gas sector. The workshop concluded with the note that with the intervention of right efforts & policies made by the industry with the help of the government, the economy of our country will surely scale new peaks.



Swachhta Pakhwada – 2021

In compliance with the guidelines of Ministry of Petroleum & Natural Gas, Government of India, CHT, in association with other offices located in OIBD Bhawan viz. OIBD, OISD, ISPRIL celebrated Swachhta Pakhwada during the fortnight of 1-15 July 2021. To make the Swachhta Pakhwada a success, CHT organized day wise programs related to cleanliness. During the fortnight, various programs viz. drawing/painting competition on cleanliness were organized among the children of CHT officers, craft competition on cleanliness among the wives of CHT officers, speech competition on cleanliness among outsourced personnel, slogan competition among CHT Officers etc. To increase awareness about

cleanliness among the general public, SanitationKits (School Bag, Water Bottle, Mask, Sanitizer, Hand Towel, Dettol Soap, Biscuit) were distributed to the children of Primary School Khangoda Village, Dadri, Gautam Buddha Nagar, UP and orphanage children at Lal Bahadur Shastri Bal Vatika Vasundhara, Ghaziabad During the Pakhwada a walkathon was also organized in which officers and staff took out banners to spread awareness about cleanliness. On the concluding day of Swachhta Pakhwada 2021, prizes were distributed to the winning participants by the ED-CHT on 15th July 2021

Glimpses of Swachhta Pakhwada 2021



Hindi Workshop organized during Hindi Pakhwada 2021

Hindi Pakhwada along with Hindi Workshop was organized from 1st to 15th September 2021 at the Centre for High Technology. Hindi Pakhwada 2021 was inaugurated by Shri P. Raman, ED-CHT (Acting In-charge), on 1st September 2021. During the Hindi Pakhwada period, many competitions were organized in which all the officers and employees of the Centre for High Technology participated enthusiastically. On the occasion of Hindi Pakhwada closing ceremony and Hindi workshop, Deputy Director (Hindi), Ministry of

Petroleum and Natural Gas, Smt. Shobhana Srivastava was present as the Chief Guest and she appealed to all CHT officials to work in Hindi. On this occasion, the Chief Guest Smt. Shobhana Srivastava and Shri P. Raman, ED-CHT (Acting In-charge) released Hindi magazine 'Rajbhasika Surabhi 2021'. The Chief Guest and the Executive Director, at the conclusion of the function, presented prizes to the winning participants thus encouraging all the participants.

Some glimpses of Hindi workshop/Hindi Pakhwada 2021





संसदीय राजभाषा समिति की पहली उप-समिति द्वारा सीएचटी हिंदी निरीक्षण

उच्च प्रौद्योगिकी केंद्र में संसदीय राजभाषा समिति की प्रथम उपसमिति द्वारा निरीक्षण 2 नवम्बर 2021 को किया गया। सीएचटी को समन्वयक की भूमिका दी गई। निरीक्षण बैठक का आयोजन संसद की राजभाषा समिति के उपाध्यक्ष एवं सांसद (लोकसभा) श्री भर्तृहरि महताब, और संयोजक सह सांसद (राज्यसभा) श्री राम चंदर जांगड़ा की अध्यक्षता में किया गया। संसद की राजभाषा समिति के अन्य सदस्यों में श्री श्रीरंग अप्पा बार्ने, सांसद (लोकसभा), श्री श्याम सिंह यादव, सांसद (लोकसभा) और श्री धर्मेन्द्र कश्यप, सांसद (लोकसभा), श्री इरन्ना कडाडी, सांसद (राज्य सभा) उपस्थित थे। समिति सचिवालय के अधिकारियों में श्री धर्मराज खटीक, सचिव, राजभाषा समिति, श्री रामेश्वर लाल मीणा, अवर सचिव, राजभाषा समिति, श्री विक्रान्त भाटिया, अनुभाग अधिकारी, राजभाषा समिति, श्री सहदेव सिंह, रिपोर्टर, राजभाषा समिति, श्री मुकेश कुमार, सहायक, राजभाषा समिति में उपस्थित थे। श्री रोहित माथुर, संयुक्त सचिव एवं श्रीमती शोभना श्रीवास्तव, उप निदेशक (हिंदी) पेट्रोलियम और प्राकृतिक गैस मंत्रालय उपस्थित थे। समिति सचिवालय के सचिव श्री धर्मराज खटीक ने संसदीय समिति के गठन की पृष्ठभूमि, समिति की उप-समितियों के गठन और उनके उत्तरदायित्वों की जानकारी दी।

निरीक्षण में सीएचटी की ओर से श्री पुचा रामन, कार्यकारी निदेशक (कार्यवाहक प्रभारी), डॉ. एन.एस. रमन, निदेशक, श्रीमती रेनू रैना, अपर निदेशक एवं श्री सत्यवीर सिंह, अपर निदेशक (मानव संसाधन) उपस्थित थे। समिति का स्वागत एवं अभिनन्दन श्री पुचा रामन, कार्यकारी निदेशक (कार्यवाहक प्रभारी) द्वारा किया गया तथा श्री सत्यवीर सिंह, अपर निदेशक (मानव संसाधन) ने सीएचटी की गतिविधियों के बारे में संक्षिप्त प्रस्तुति दी। माननीय श्री भर्तृहरि महताब जी ने अपने संक्षिप्त संबोधन में राजभाषा हिंदी के प्रयोग की आवश्यकता पर प्रकाश डाला। महामहिम राष्ट्रपति के आदेशों का उल्लेख करते हुए उन्होंने टिप्पणी की कि स्वतंत्रता प्राप्ति के इतने लंबे समय के बाद भी एवं हिंदी को राजभाषा घोषित करने के बाद भी भारत में कुछ कार्यालयों में राजभाषा हिन्दी का प्रयोग ठीक से नहीं हो रहा है। उन्होंने शत-प्रतिशत पत्राचार पर विशेष ध्यान देने के निर्देश दिए, जिसका अनुपालन सभी कार्यालयों द्वारा किया जाना है। श्री भर्तृहरि महताब, उपाध्यक्ष, संसद की राजभाषा समिति और सांसद (लोकसभा) और अन्य सदस्य सीएचटी कार्यालय में हिंदी के उपयोग की प्रगति को देखकर अपनी प्रसन्नता व्यक्त की और इसके लिए सीएचटी की सराहना भी की। कार्यकारी निदेशक (कार्यवाहक प्रभारी), सीएचटी ने आश्वासन दिया कि वह व्यक्तिगत रूप से अधिक ध्यान देंगे ताकि सीएचटी में हिंदी के उपयोग में और सुधार हो सके और सीएचटी में 100% लक्ष्य प्राप्त किया जा सके। माननीय श्री भर्तृहरि महताब, उपाध्यक्ष, संसदीय राजभाषा समिति और सांसद (लोकसभा) ने श्री पुचा रामन जी को संसदीय राजभाषा समिति द्वारा संकलित रिपोर्ट प्रस्तुत किया (जिसमें प्रथम नौ खंडों पर राष्ट्रपति के आदेश की समिति रिपोर्ट है) एवं एक प्रशस्ति पत्र भी प्रदान किया। इस प्रशस्ति पत्र में यह भी उल्लेख किया गया है कि इस निरीक्षण कार्यक्रम के संबंध में, सीएचटी ने सभी प्रकार की व्यवस्था करके पूर्ण समर्थन और सहयोग प्रदान किया है और निरीक्षण के दौरान समिति सचिवालय के साथ निरंतर संपर्क बनाए रखा है, जिससे समिति को अपना कार्यक्रम पूरा करने में सुविधा हुई है। इसके लिए समिति की ओर से सीएचटी कार्यालय का विशेष धन्यवाद दिया गया। बैठक के अंत में श्री सत्यवीर सिंह, अपर निदेशक (मानव संसाधन), उच्च प्रौद्योगिकी केंद्र ने संसदीय समिति के माननीय सदस्यों और समिति सचिवालय के संबंधित अधिकारियों, पेट्रोलियम और प्राकृतिक गैस मंत्रालय के अधिकारियों और अन्य सहयोगियों को धन्यवाद दिया।

Some highlights of the inspection of the Centre for High Technology by the First Sub-Committee of the Parliamentary Committee on Official Language



73rd Republic Day Celebrations in CHT

The 73rd Republic Day celebrations were organized on 26th January 2022 in CHT office. Shri Alok Sharma, ED-CHT, unfurled the Indian Tricolor in the presence of CHT officials and security guards. On this occasion, ED-CHT spoke about the history of Republic Day and the importance of the Constitution of India in today's times. He reiterated CHT's commitment in the Energy Sector of our country and pledge to dedicate our services for the progress of the Nation. He greeted all the officials present on the occasion of the 73rd Republic Day.



Glimpses of 73rd Republic Day Celebrations in CHT

International Women's Day Celebrations at CHT office

Centre for High Technology celebrated International Women's Day-2022 on 8th March 2022. International Women's Day is a global day celebrating the social, economic, cultural and political achievements of women. The day also marks a call for action in accelerating women's equality. On this occasion, Centre for High Technology organized a Workshop on "Growing Significance of Women's Role in Corporate Leadership". All officials at CHT whole-heartedly participated in the Workshop and

the discussion spanned across several areas, including education and skill development, the need to strengthen the ecosystem for bringing in diversity, creating a culture of learning, psychological well-being and the scope of nurturing more women in becoming financially independent. This celebration of International Women's Day reiterated the growing significance of a woman in building a strong foundation in our society.



Glimpses of International Women's Day Celebrations at CHT

आईएसओ 9001 : 2015 ऑडिट

द्वितीय आवधिक आईएसओ 9001:2015 ऑडिट मेसेर्स आईसीएस द्वारा 28 जून 2021 को सीएचटी में सफलतापूर्वक आयोजित किया गया था। ऑडिटर ने सीएचटी के विभिन्न तकनीकी प्रक्रियाओं और परियोजनाओं सहित, मानव संसाधन, वित्त कार्यों की समीक्षा करके, इस ऑडिट को ऑनलाइन किया।



7 वाँ अन्तराष्ट्रीय योग दिवस

भारत सरकार के तेल एवं प्राकृतिक गैस मंत्रालय के दिशा-निर्देशों के अनुरूप उच्च प्रौद्योगिकी केन्द्र में दिनांक 21 जून 2021 को सातवाँ अंतराष्ट्रीय योग दिवस मनाया गया। इस अवसर पर देश भर में कोरोना महामारी की वजह से कार्यालय के सभी अधिकारियों एवं कर्मचारियों ने अपने घर पर ही योगाभ्यास किया। अधिकारियों एवं कर्मचारियों ने विभिन्न प्रकार की योग क्रियाएँ की जैसे कि अनुलोम-विलोम, आँखों के व्यायाम, सूर्य नमस्कार, ताड़ासन योग, वृक्षासन योग, सुखासन योग आदि। इन में से कुछ क्रियाएँ कार्यालय में भी की जा सकती हैं तथा योग का लाभ उठाया जा सकता है।

इस अवसर पर सीएचटी के अधिकारियों के परिवार के साथ योग करते हुए कुछ झलकियाँ



"The growth story of India depends on its success in science and technology sector. My motto for the young scientists in this country is - Innovate, Patent, Produce and Prosper. These four steps will lead our country towards faster development."

- Narendra Modi
Hon'ble Prime Minister of India

