

Securing Zero Black Liquor Discharge in Pulp and Paper Industries of River Ganga basin through Participatory approach

The pulp and paper industry has been considered a large consumer of freshwater and one of the largest sources of surface water pollution. The Indian paper industry are highly intensive in terms of consumption of raw material, chemicals, energy, and water thereby generating high volume of wastewater with complex characteristics, black liquor with high Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS). Central Pollution Control Board (CPCB), after consultation with different stakeholders prepared an action plan for black liquor management in Pulp and Paper industries. The action plan was successfully implemented and resulted into zero black liquor discharge in river Ganga basin since 2014. To ensure zero black liquor discharge, around 100 chemical pulping digesters were dismantled, and 7 Chemical Recovery Plants (CRP) were commissioned for black liquor management. The initiatives and assurance of zero black liquor discharge from Pulp and Paper Industry in Uttarakhand and Uttar Pradesh was acknowledged by Hon'ble Prime Minister of India in Mann ki Baat, Episode-19th dated 24/04/2016. The Pulp and Paper industries located in Ganga basin are being inspected annually with technology partners for verification and to ensure no black liquor discharge into recipient water bodies. Implementation of zero black liquor discharge led to improvement in water quality of recipient water bodies such as river Dhela, Bahela, Kosi and Ramganga in terms of Dissolved Oxygen (DO) and Bio-chemical Oxygen Demand (BOD) and no incidence of coloured water discharge observed in river Ganga since 2017. Implementation of action plan and continuous surveillance through annual inspection of pulp and paper industries led to reduction in pollution load from 76.5 TPD to 1.74 TPD in 2021 as compared to 2011. The successful case of this holistic participatory approach and policy needs to be implemented nationwide for black liquor management in Pulp and Paper mills.

Key words: Pulp and paper, Black liquor, Water pollution, Chemical recovery, Mann Ki Baat, Action plan.

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Introduction

River Ganga is one of the main sources of livelihood for western Indo-Gangetic plane inhabitants. Apart from the livelihood, the river holds special place in Indian peoples' life due to its sacred belief. Two major head streams i.e. river Bhagirathi and river Alaknanda originate from glaciers located in Himalayan mountains and meet at Devprayag to form river Ganga. It is the 2525 km long river with catchment area of 1086000 km² (Trivedi, 2010; Ranjan *et al.*, 2020 and Vidyarthi *et al.*, 2020). The river Ganga flows in five states, Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal before confluence into Bay of Bengal. The major tributaries of the river Ganga are Ramganga, Kali East, Yamuna, Tons, Gomti, Sone, Ghagra, Gandak, Kosi, Mahananda and Damodar. These tributaries are also having several sub-tributaries and 2nd, 3rd, and 4th order drains, which carries the pollution load. Each state contributed significant amount of pollution load in the river by discharging untreated sewage and industrial wastewater. The industrial pollution majorly comes from the industries like; Distillery, Pulp and Paper, Sugars and others.

The impact of participatory approach, technological intervention and action plan for black liquor management in pulp and paper industries of river Ganga basin have been highlighted.

R.K. Singh, A.K. Vidyarthi, A. Shukla, P. Ranjan, V. Kumar¹ and R. Kumar¹
Central Pollution Control Board,
East Arjun Nagar, Delhi – 110032
[#]Email: rksingh.evs@gmail.com

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¹Indian Institute of Technology, Delhi– 110016.

In 2011, CPCB estimated that, Uttarakhand (UK) and Uttar Pradesh (UP) stretch contributed a significant pollution load in river Ganga by discharging 1,61,792 KLD and 73,470 KLD untreated/partially treated effluent, respectively. Out of the total discharge, Pulp and Paper industries were one of the major contributors with industrial discharge of 146,000KLD (90% of industrial discharge) and 39,220 KLD (53% of industrial discharge) from UK and UP respectively (Feasibility report CPCB; 2014). Paper industries of the states of UK and UP were mainly located in the cluster of Kashipur, Meerut, Muzaffarnagar, Moradabad having production varying from 30-250 TPD. Most of these industries located in these clusters had small production units which utilized agro-residue and wastepaper as raw material and were installed without Chemical Recovery Plant (CRP) (Jwala *et al.*, 2017). Furthermore, high silica content, adverse thermal and flow properties of agro-residue black liquor deterred industries to install CRP and adopt alternative environmental management options. In addition, these industries needed to change their product line frequently, which lead to huge wastewater generation. Most of these industries were discharging either partially treated black liquor or untreated black liquor which resulted into deterioration of water quality of recipient water bodies (Endlay *et al.*, 2022 and Vidyarthi, 2018). During 2009, the value of Dissolved Oxygen (DO) in river Dhela, Bahela was observed as Nil, whereas the value of DO in river Kosi and Ramganga were in the range of 3.5-7.8 mg/L and 5.4-9.2 mg/L, respectively. In 2009, the BOD value of river Dhela, Bahela, Kosi and Ramganga was observed as 340 mg/L, 44-179 mg/l, 10 mg/l and 4-8.4 mg/l, respectively (Rana *et al.*, 2022). Pulp and paper industries specially those using agro-residue/wood as raw material and with production capacity of <100 TPD were discharging black liquor directly into recipient water bodies. The black liquor has high solid content (8-12%), and the COD varies in the range of 75000-125000 mg/L. The black liquor was the main reason behind the strange colour of these tributaries and river Ganga. In 2007, the black liquor generated from these industries was 10000KLD out of which 4000 KLD was discharged into river Ganga. The generation of black liquor steadily increased in the subsequent years due to increase in production. In 2011, the black liquor production was 17500KLD and black liquor discharge was 6000 KLD. Apart from the black liquor management most of the pulp and paper mills were having effluent treatment facilities to treat generated wastewater but that too were not up-to the satisfactory level or most of them were having inadequate facility (Endlay *et al.*, 2022 and Vidyarthi, 2018).

In the above context CPCB in association with technical institutions were involved in Techno-economic feasibility study for Setting up of Common Chemical Recovery Plant (CCRP) based on conventional technology and standalone modified fluidized bed chemical recovery system for agro/ wood-based Pulp

and Paper industries operating in identified clusters of Uttar Pradesh (UP) and Uttarakhand (UK) for management of Black liquor (Endlay *et al.*, 2022). In consultation with all the stakeholders and in 2012, CPCB formulated and implemented an action plan for black liquor management for pulp and paper sector, and as a result despite of 18000 KLD black liquor generation, the discharge of black liquor was found to be zero in the Ganga river basin (cGanga Report on Pulp and Paper, 2019). In the 19th Episode of Mann Ki Baat dated 24/04/2016, Hon'ble PM also acknowledged the efforts of eliminating black liquor discharge from Pulp and Paper industry in Uttarakhand and Uttar Pradesh. This paper deals with participatory approach adopted to assure proper management of black liquor a systematic participatory and stakeholder (Regulatory bodies, Technical institution, Industrial Association, NGO, and Locals).

Methodology

Problem Identification through Survey and Primary Data Collection

Pollution load assessment of River Ganga performed by CPCB in 2011 shows that the quality of river Ganga water was severely affected. CPCB with SPCB performed an extensive survey (physical and documentation) to map all the tributaries, drain, intensity of pollution load and sectoral specific major pollutants. In the second step of the survey, pulp and paper industry were inventoried and assessed. The pulp and paper industry required a huge amount of water during various processes of paper making, which generates huge amounts of wastewater of different pollution parameters.

To Identify pulp and paper sector inherent problems

For the assessment of point pollution source, industrial sector specific inherent problem identification was carried-out, Sector specific inventory (Questionnaire) was prepared for problem identification for pulp and paper sector. Inventorization of pulp and paper industries of UK and UP was carried out. Pulp and paper industries of UK and UP states mainly located in four clusters: Kashipur, Meerut, Muzaffarnagar, and Moradabad. A total 60 pulp and paper industries located in four clusters of these two states were inventoried. Out of 60 industries, 20 and 40 industries were located in UK and UP respectively.

Inventorization and Status of Pulp and Paper Mill

In the preparation of inventory several aspects to identify the problem assessed; type of raw material used, raw material to pulp conversion process (Pulping), quality enhancement process (Bleaching), type of product manufactured, freshwater consumption and source, availability of generated wastewater treatment facility, treated water discharge mechanism, housekeeping, in-house technical capacity etc. Apart from inventorization, analysis of section wise

wastewater parameters was also carried out.

Participatory Approach

In the preparation of pollution load abatement strategy, participatory approach was applied in which, experts from various fields were brought together and brain storming sessions were carried out. Experts from Indian Institute of Technology (IITs), Centre Pulp and Paper Research Institute (CPPRI), Indian Pulp and Paper Industrial Association (IPPIA), and Industry people were involved in the exercise (Fig. 1). A bond between all the stockholders was developed to prepare and execute the charter (Charter, 2015).



Fig. 1: Participatory approach for pollution reduction from pulp and paper sector

Action Plan for black liquor management

The action plan for black liquor management includes; Installation and commissioning of Chemical recovery Plant (CRP), Common Chemical Recovery Plant (CCRP), Flow measurement of Black Liquor, installation of Mass Flow meter (connected to PLC based logic or DCS), Recording of daily, to-date monthly and to-date yearly production of Soda Ash (in MT), installation of separate steam mass flow meter in CRP, record keeping of steam consumption in evaporators (MT/Day), recording of Steam Economy of evaporators, Consumption of power in the total CRP in Units/Day, Separate power meter (with totalizer) connected to PLC based logic or DCS for the CRP, record for consumption of Caustic in cooking digester, Declaration of total caustic purchased and total Soda Ash produced in a month, record for input raw materials utility (like steam, power, chemicals etc) effluent flow and pulp production data on daily / monthly / yearly basis, record for effluent generation and discharge, facility for transportation of black liquor to Common CRP (CCRP) through pipelines only, installation of cameras at the discharge points and restriction to run digesters for pulping by Paper Mills without having CRP facility or membership of a common CRP.

Regular monitoring of Pulp and Paper industries

(a) Monitoring and Reporting

Under monitoring and reporting, paper industries required to submit monthly data of expected total running hours of evaporators and FBR, expected production of black liquor and Soda Ash and prior information to CPCB/ SPCB in case of shutdown or breakdown of the CRP and verification of declaration by industry for CRP operation through SPCB. Paper industries were required to submit report for physical verification of black liquor management and compliance through third party technical institute of repute.

(b) Real-time monitoring of CRP operation

Installation and connectivity of camera (facing chimney) to SPCBs/ PCCs server for online monitoring of FBR.

Connection of flow measurement and power meter to PLC based logic or DCS.

(c) Scrapping/ Dismantling of digester

The CPCB also made it mandatory to scrape the digester of the industries those who switched their raw material from agro/ wood to wastepaper or does not have facility of chemical recovery (Fig. 2).

(d) Steps taken for water conservation and improved water use efficiency

(i) Development of model Consolidated Consent and Authorization (CCA)

CPCB developed Model template for Consolidated Consent & Authorization (CCA) incorporating novel and proven technologies, norms for freshwater consumption, wastewater discharge as key performance indicators for adoption by seven State PCBs in Ganga and Yamuna main stem states.

Enforcement of model CCA in seven SPCBs/ PCCs of Ganga and Yamuna main stem states underway with three SPCBs namely UPPCB, BSPCB and UKPCB already issuing fresh CTO as per model template.

(ii) Regulatory framework for groundwater abstraction

In consultation with Central Ground Water Authority, it was made mandatory that specific freshwater consumption limit as per model CCA to be incorporated in the NOC for groundwater.

(e) Regulatory framework for ensuring zero black liquor discharge

CPCB is carrying out inspection of 100% of GPIs of Ganga basin since 2017.

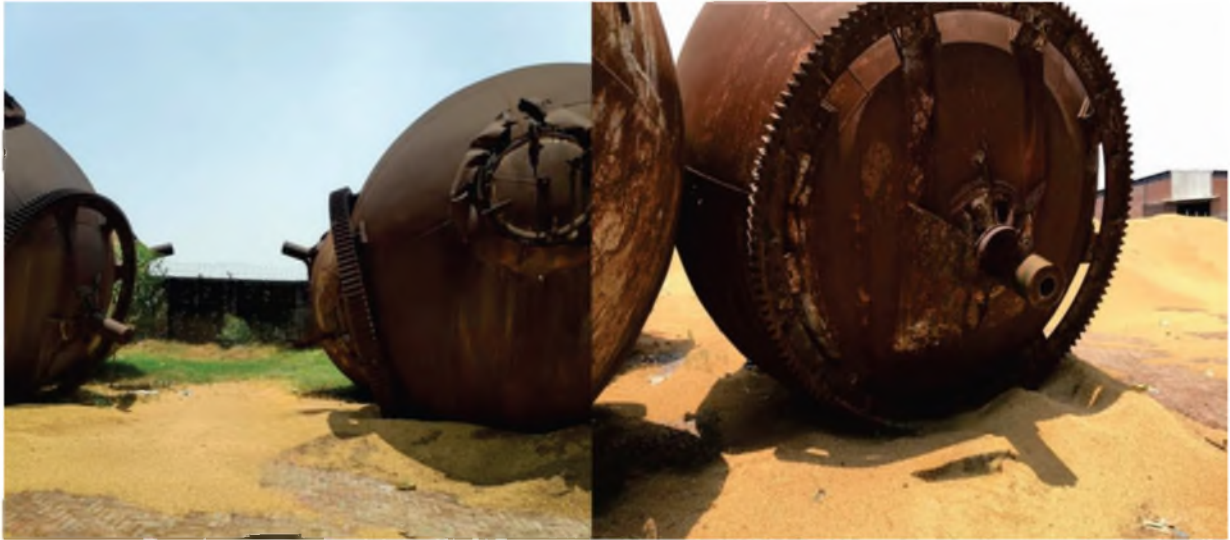


Fig. 2: Dismantling of digestors at pulp and paper industries not having CRP.

The inspection includes, ensurance of zero black liqor discharge, verification of compliace w.r.t. effluent discharge norms, material baiancing, water audit etc,

it also includes collection of Primary data regarding validity of Consent to Operate (CTO), black liqor management, recycle and reuse of treated effluent, verification of route of Zero Liquid Discharge (ZLD), performance assessment of Effluent Treatment Plant (ETP) system etc.

Total number of Pulp and Paper industries inspected was 90 in 2017, 85 in 2018, 93 in 2019, 100 in 2020 and 97 in 2021 in Ganga main stem states. In 2021 total paper production in Ganga main stem was estimated as 11942.25 tons per day. (CPCB Report, Sept' 2022)

The BOD load in the effluent discharged by Pulp paper industries reduced significantly from 76.5 TPD to 1.74 TPD i.e. 97.7% reduction in BOD load is observed in 2021 in compared to 2011 (CPCB Report, Sept' 2022)

Impact of Action plan on black liqor management

Most of the Pulp and Paper industries located in the Kashipur, and Muzaffarnagar cluster were agro-based. These industries were discharging 2000 and 6000 m³/day black liqor directly into water bodies without any treatment (cGanga Report on Pulp and Paper, 2019). These categories of industries used to discharge a significant amount of Black liqor before the implementation of the action plan as they were not equipped with the Chemical recovery facility (CRP).

(a) Kashipur Cluster

The Kashipur industrial cluster had 26% agro-based

industries and black liqor generation grew with increase in production. Till 2004, all these industries were discharging 100% of generated black liqor into nearby water bodies. From 2005 onwards, industries started installing CRP and as a result the black liqor discharge reduced consequently and by 2012 the Kashipur cluster achieved zero black liqor discharge. From year 1983 to 2017, production in the Kashipur cluster grew 20 times and the black liqor generation grew 28 times (Fig. 3) (cGanga Report on Pulp and Paper, 2019).

(b) Muzaffarnagar Cluster

The Muzaffarnagar industrial cluster had 25% agro-based Pulp and Paper industries. The black liqor generation increased with an increase in production from year 1985 to 2009. Till 2009, all of these industries were discharging 100% of generated black liqor into nearby water bodies. From the year 2010 onwards, industries started installing CRP and CCRP leading to reduction in black liqor and achieved zero black liqor discharge by year 2014 (Fig. 4). From the year 1985 to 2017, production in the Muzaffarnagar cluster grew 18 times and the black liqor generation grew 11 times (cGanga Report on Pulp and Paper, 2019).

(c) The Ganga River Basin of Uttarakhand and Uttar Pradesh

The Paper production of the industries located in Ganga River basin of UK and UP including Kashipur and Muzaffarnagar cluster was found 3523 TPD in the year 2017 and these industries were found to be generating 18797 m³/day of black liqor. Since 2014, zero black liqor discharge was achieved (Fig. 5) (cGanga Report on Pulp and Paper, 2019).

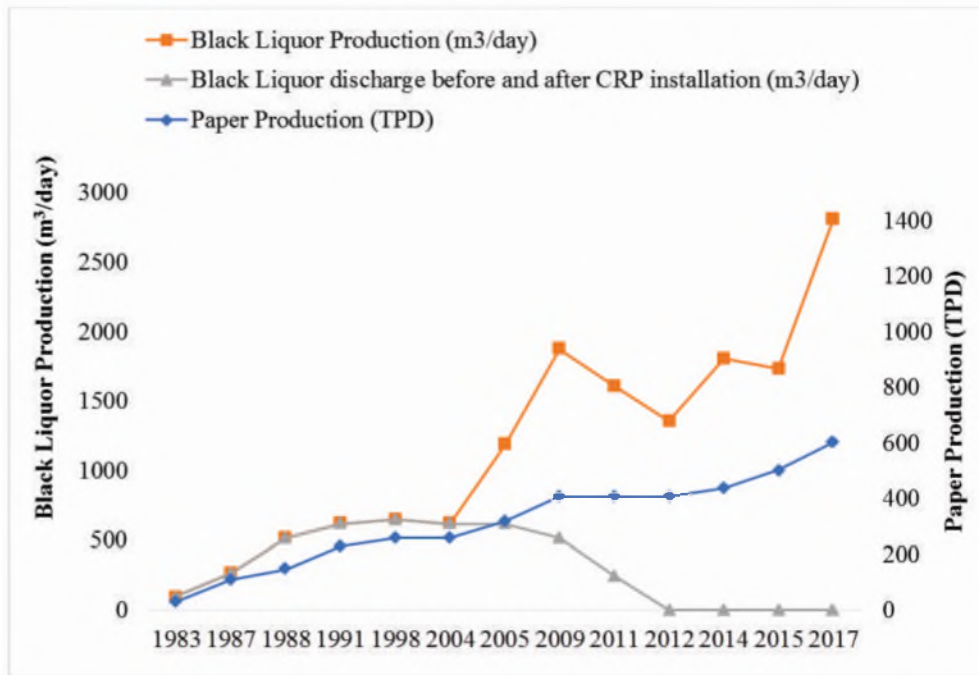


Fig. 3: Paper production, Black liquor generation and discharge of Kashipur Cluster during 1983 to 2017

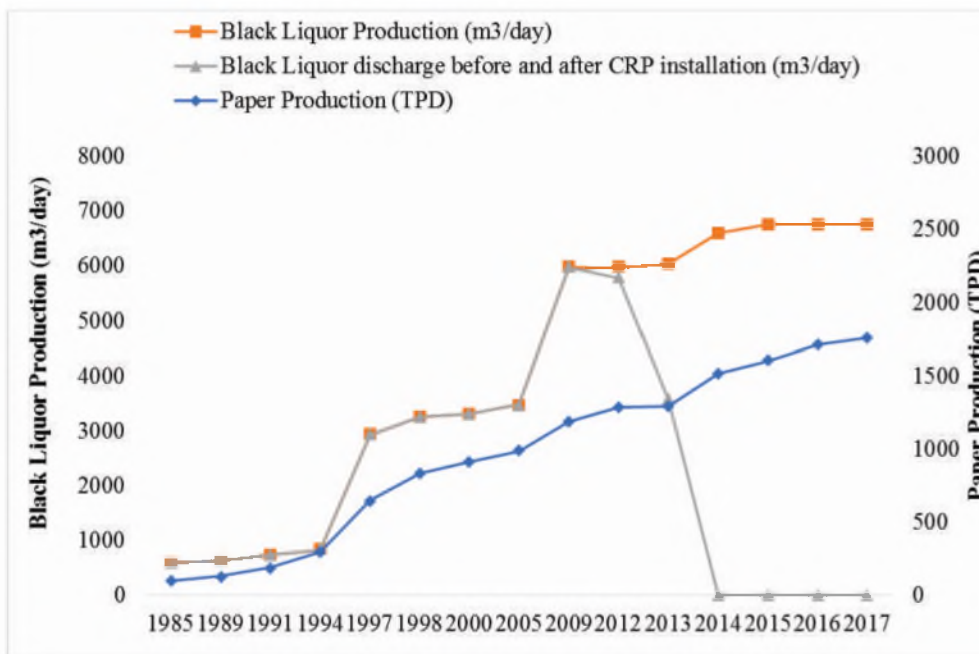


Fig. 4: Paper production, Black liquor generation and discharge of Muzaffarnagar Cluster during 1985 to 2017.

(d) Water quality of tributaries

Improvement in water quality of river Ganga and its tributaries have been observed since 2009. The DO level in 2022 as compared to 2009 improved from

Nil to 8.8 mg/L in river Dhela, Nil to 7.8 mg/L in river Bahela, 3.5-7.8 to 6-7.6 mg/L in river Kosi and 5.4-9.2 mg/l to 6.6-9.3 mg/L in river Ramganga. The BOD level in 2022 as compared to 2009 reduced from 340 mg/L to 2-29 mg/L in river Dhela, 44-179

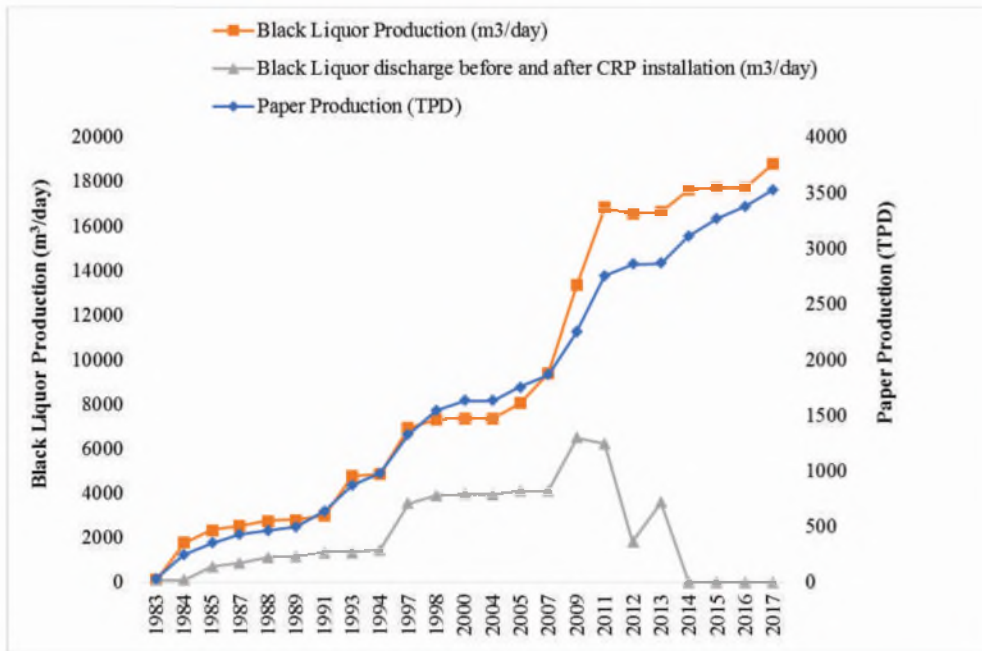


Fig. 5: Paper production, Black liquor generation and discharge into Ganga River from Uttarakhand and Uttar Pradesh from 1983 to 2017

mg/L to 2-58 mg/L in river Baheia, 10 mg/L to 3-4 mg/L in river Kosi and 4-8.4 mg/L to 3-6 mg/L in river Ramganga (Rana *et al.*, 2022).

Conclusion

The implementation of action plan for black liquor management resulted in zero black liquor discharge by dismantling of about 100 chemical pulping digesters and commissioning of 7 chemical recovery plants. Implementation of action plan and continuous surveillance through annual inspection of pulp and paper industries led to reduction in pollution load from 76.5 TPD to 1.74 TPD in 2021 as compared to 2011. As a result of zero black liquor discharge, improvement in water quality of rivers, Dheia, Baheia, Kosi and Ramganga was observed in terms of DO and BOD and no incidence of coloured water in river Ganga observed since 2017.

भागीदारी दृष्टिकोण के माध्यम से गंगा नदी बेसिन के लुगदी और कागज उद्योगों में शून्य ब्लैक लिक्वर उत्स्रवाह को सुनिश्चित करना

आर.के. सिंह, ए.के. विद्यार्थी, ए. शुक्ला, पी. रंजन, वी.कुमार और आर. कुमार
सारांश

लुगदी और कागज उद्योग को ताजे पानी का एक बड़ा उपभोक्ता और सतही जल प्रदूषण के सबसे बड़े स्रोतों में से एक माना जाता है। भारतीय कागज उद्योग कच्चे माल, रसायन, ऊर्जा और पानी की खपत के मामले में अत्यधिक सघन है, जिससे जटिल विशेषताओं के साथ उच्च मात्रा में

अपशिष्ट जल उत्पन्न होता है, ब्लैक लिक्वर में उच्च जैव रासायनिक ऑक्सीजन मांग (बीओडी), रासायनिक ऑक्सीजन मांग (सीओडी) और कुल निलंबित ठोस (टीएसएस) की काफी मात्रा होती है। केंद्रीय प्रदूषण नियंत्रण बोर्ड (सीपीसीबी) ने विभिन्न हितधारकों के साथ परामर्श के बाद लुगदी और कागज उद्योगों में ब्लैक लिक्वर प्रबंधन के लिए एक कार्य योजना तैयार की। कार्य योजना को सफलतापूर्वक लागू किया गया और 2014 के बाद से गंगा नदी बेसिन में शून्य ब्लैक लिक्वर उत्स्रवाह हुआ। शून्य ब्लैक लिक्वर उत्स्रवाह सुनिश्चित करने के लिए, लगभग 100 रासायनिक पल्पिंग डाइजेस्टर को नष्ट कर दिया गया, और ब्लैक लिक्वर प्रबंधन के लिए 7 रासायनिक रिकवरी प्लांट (सीआरपी) चालू किए गए। उत्तराखंड और उत्तर प्रदेश में लुगदी और कागज उद्योगों से शून्य ब्लैक लिक्वर उत्स्रवाह सुनिश्चित करने की पहल को भारत के माननीय प्रधानमंत्री द्वारा मन की बात, एपिसोड -19 दिनांक 24/04/2016 में अभिस्वीकार किया गया था। गंगा बेसिन में स्थित लुगदी और कागज उद्योगों के सत्थापन के लिए प्रौद्योगिकी भागीदारों के साथ सालाना निरीक्षण किया जा रहा है और यह सुनिश्चित किया जा रहा है कि प्राप्तकर्ता जल निकारों में ब्लैक लिक्वर उत्स्रवाह नहीं हो रहा है। शून्य ब्लैक लिक्वर उत्स्रवाह के कार्यान्वयन से प्राप्तकर्ता जल निकारों जैसे देला, बहेला, कोसी और रामगंगा नदी में घुलित ऑक्सीजन (डीओ) और जैव-रासायनिक ऑक्सीजन डिमांड (बीओडी) की जल गुणवत्ता में सुधार हुआ और 2017 से गंगा नदी में रंगीन पानी के उत्स्रवाह की कोई घटना नहीं देखी गई। लुगदी और कागज उद्योगों के वार्षिक निरीक्षण के माध्यम से कार्य योजना के कार्यान्वयन और निरंतर निगरानी के कारण 2011 की तुलना में 2021 में प्रदूषण भार 76.5 टीपीडी से घटकर 1.74 टीपीडी हो गया। इस समग्र भागीदारी दृष्टिकोण और नीतिगत जरूरतों के सफल प्रकरण को देश भर के लुगदी और कागज उद्योग में ब्लैक लिक्वर के प्रबंधन के लिए लागू किया जाना चाहिए।

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