With the water crisis looming the country and fresh water availability increasingly becoming scarce, India is all set to frame a National Policy on ‘Reuse of treated Wastewater’. It is in this regard, two recent developments need worth mentioning. Firstly, Bengaluru Civic body the Bruhat Bengaluru Mahanagara Pulike (BBMP) has decided to make it mandatory for building owners to use treated water at various sewage treatment plants (STPs) in the city to construct buildings. Secondly as per the September 2019 CPCB Guidelines for Utilisation of Treated Effluent in Irrigation, “ZLD needs to be considered with respect to use of effluents in the industrial processes not in terms of its disposal on land or farm”.

However, the key question is that are we ready with the treated wastewater having quality to be actually using back in the process? The answer is that at present, the technologies and integrated approaches which lead to wastewater treatment does not treat wastewater appropriately; as the result ‘inadequately’ treated wastewater find use either in drains or in secondary processes like horticulture, gardening, washing, flushing, etc. For primary processes like the water for cooling towers, boilers, formulations, manufacturing, construction etc, fresh ground water is still required, or water is being recovered from tertiary treatment systems like RO/MEE/MVR etc, which incur huge land and maintenance costs at the same time being highly energy intensive and unsustainable. Hence innovation in ‘adequately’ treating wastewater and thus enhancing water re-use efficiency is the need of the hour!

In this pursuit, TERI (The Energy and Resources Institute, New Delhi) has patented and developed an innovative technology called TERI Advanced Oxidation Technology (TADOX), which aims at complete end-to-end treatment of wastewater effluent streams of sewage and / or mixed streams of industrial effluents having high colour, COD, BOD, TSS, non-biodegradable and persistent organic pollutants (POPs), generated from highly polluting industries like textile, dyeing, chemical, pharmaceuticals, oil & gas, slaughter house, tannery, etc. TADOX integrates Nanotechnology and Advanced Oxidation Processes in current systems and together make the treated water having process water quality, suitable for any industrial application. These will be discussed in the light of results obtained at pilot scale towards treatment of sewage and wastewater generated from highly polluting industries like textile and dyeing using TADOX.

Figure 1 depicts complete end-to-end treatment of wastewater obtained from an equalization tank of an ETP of a cotton manufacturing and dyeing unit in Andhra Pradesh.
From the figure, it could be seen that complete decolourization is obtained after treatment. Results obtained from NABL accredited laboratory show significant removal of BOD (95%) from 255 to 12 mg/l; COD (91%) from 1360 to 128 mg/l; TSS removal (99.5%) from 850 to 4 mg/l; TDS removal (96%) from 3823 to 163 mg/l and Hardness (100%) from 60 to undetectable values in pre and post treated sample. The treated water achieved not just CPCB, Government of India discharged norms but also achieved process water quality, where this water could be reused in process and achieve ZLD; Also there was no use of any kind of bioremediation method at any stage of treatment and complete end-to-end treatment took just 5 h.

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The effluent comprises of sewage water, kitchen wastewater and laundry wastewater post screening and oil & grease removal stage. As shown in the figure, the sample was highly coloured with visible settleable and suspended solids with strong objectionable odour. Post treatment the change in sample could be clearly seen, with complete removal of colour and significant aesthetic difference. Results obtained from NABL accredited laboratory show significant removal of BOD (70%) from 74 to 22 mg/l; COD (74%) from 300 to 78 mg/l; TDS removal (81%) from 591 to 111 mg/l and Hardness (95%) from 160 to 8 mg/l in pre and post treated sample respectively. The sample exceeded the desired quality of regulatory norms.

TADOX technology is ready for field scale trials and installations and has following focus areas:

- Retrofitting according to streams in existing systems, eg (a) at pre-biological stage for high COD and coloured streams; (b) at post-biological stage for high BOD streams; (c) No bioremediation at all in some streams, leads to smaller footprint, lesser land requirement and hence reduced CAPEX; (d) at pre-RO and MEE stage, to enhance efficiency and life span of RO and reduce overall load on MEE, etc. and (e) at the polishing stage, eg, post MEE condensate to eliminate COD;
- Obtaining Industrial Process water quality in treated water enables ZLD in true sense and also source of revenue and better management for existing/new STPs and ETPs;
- Technology being highly advanced, more efficient (complete treatment in few hours), clean, green, completely automated, resource and energy efficient further ensures OPEX to be reduced by 30-40%.

Hence such technological innovations and interventions are expected to adequately treat wastewater, enhance water reuse efficiency with sustainably conserving and managing water resources. Also these could be used with small footprint, as decentralized treatment options in townships and upcoming Smart Cities.

Figure 2 depicts complete end-to-end treatment of wastewater obtained from an equalisation tank of a sewage treatment plant (STP) of a luxury hotel in Gurugram, Haryana.

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TADOX technology is ready for field scale trials and installations and has following focus areas:

- Providing better alternatives to conventional chemicals and overall very less use of chemicals in treatment,
- Thereby generating almost ‘sludge free’ treatment with further reducing secondary pollution and problems associated with sludge management,
- Retrofitting according to streams in existing systems, eg (a) at pre-biological stage for high COD and coloured streams; (b) at post-biological stage for high BOD streams; (c) No bioremediation at all in some streams, leads to smaller foot print, lesser land requirement and hence reduced CAPEX; (d) at pre-RO and MEE stage, to enhance efficiency and life span of RO and reduce overall load on MEE, etc. and (e) at the polishing stage, eg, post MEE condensate to eliminate COD;
- Obtaining Industrial Process water quality in treated water enables ZLD in true sense and also source of revenue and better management for existing/new STPs and ETPs;
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**Figure 2: Pre and Post Treated sewage sample of the inlet of STP of a luxury hotel**

- a. Inlet (Luxury Hotel)
- b. Post Treated

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