Pulp & Paper Mill Enhancements for Green Productivity Benefits

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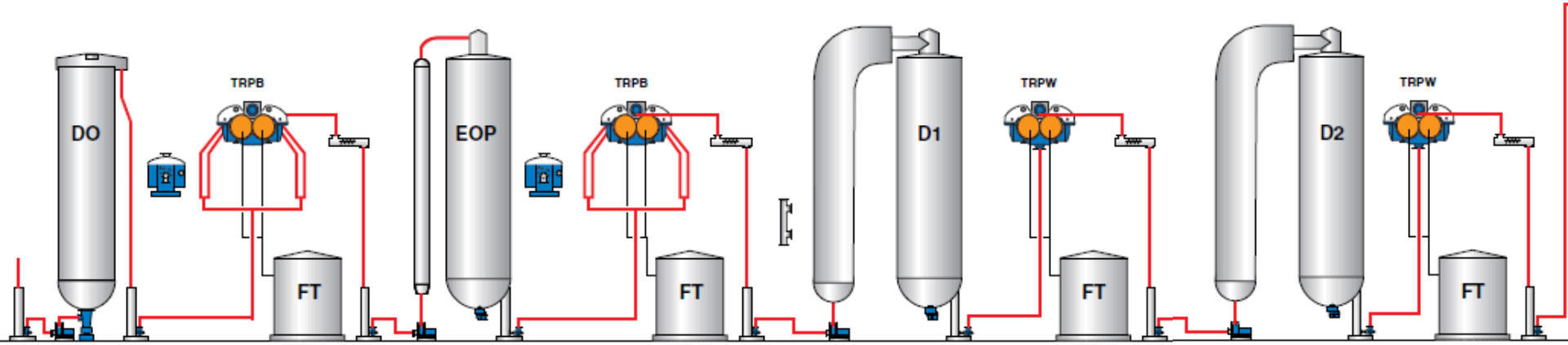
Introduction

New pollution control measures require mills to:

- **Reduce COD discharge**
- **Reduce effluent colour**
- **Reduce effluent volume**
- **Strive for Zero Discharge**

Reference Mill D-Eop-D-D



ClO_2, kg/adt	14.4
H_2O_2, kg/adt	2.8
NaOH, kg/adt	12
Effluent Vol. m^3 / adt	12
COD, kg/adt	28
Colour, kg/adt	13

FENG, Y., ZeTrac Ozone Bleaching – Environmental and Cost Benefits, Proceedings of China Paper 2012 Conference, Shanghai

Introducing Ozone Bleaching

Ozone bleaching benefits include:

- **Lower bleaching chemical costs:**
  - **ozone has similar cost to chlorine dioxide, but 1.7 higher oxidation power**
- **Lower brightness reversion**
  - **thanks to ozone action on HexA**
- **10% lower energy requirements for refining**

- **Significant reduction in COD, AOX colour discharge**

Z-ECF Bleaching Sequences

- Z/D-Eop-D and Ze-D-P, for kraft pulp mills producing paper grades

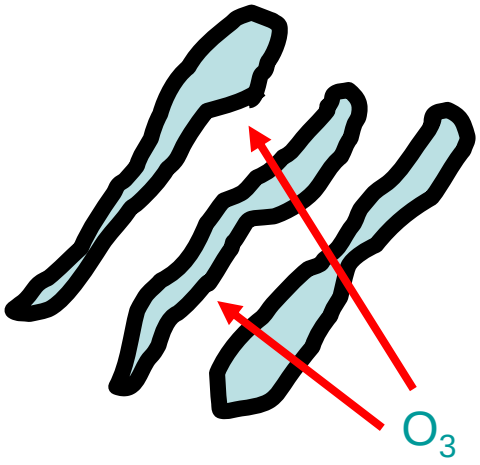
- Z/D-Eop-D and Ze-D-P, for swing kraft pulp mills producing alternatively viscose and paper grades

- A-Z-P, Z/Q-P or Zq-P for kraft pulp mills producing only viscose grades

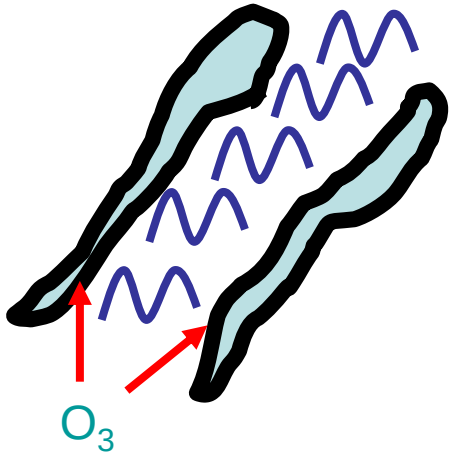
- Eop-Z-P for sulfite pulp (without prior oxygen delignification in the case of hardwood)

Ozone Bleaching Alternatives

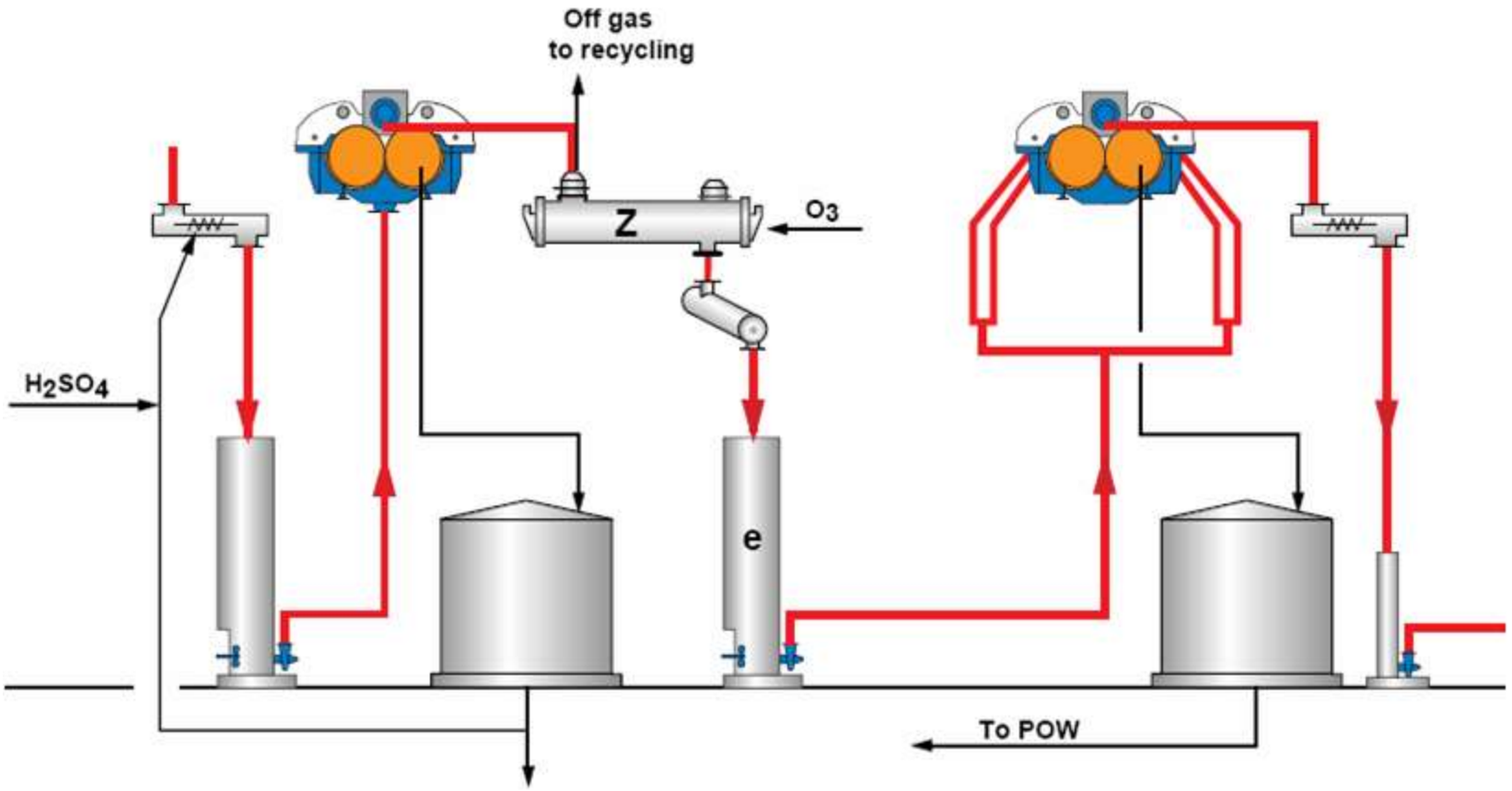
High Consistency (HC),
40% Pulp Consistency



Medium Consistency (MC),
10% Pulp Consistency

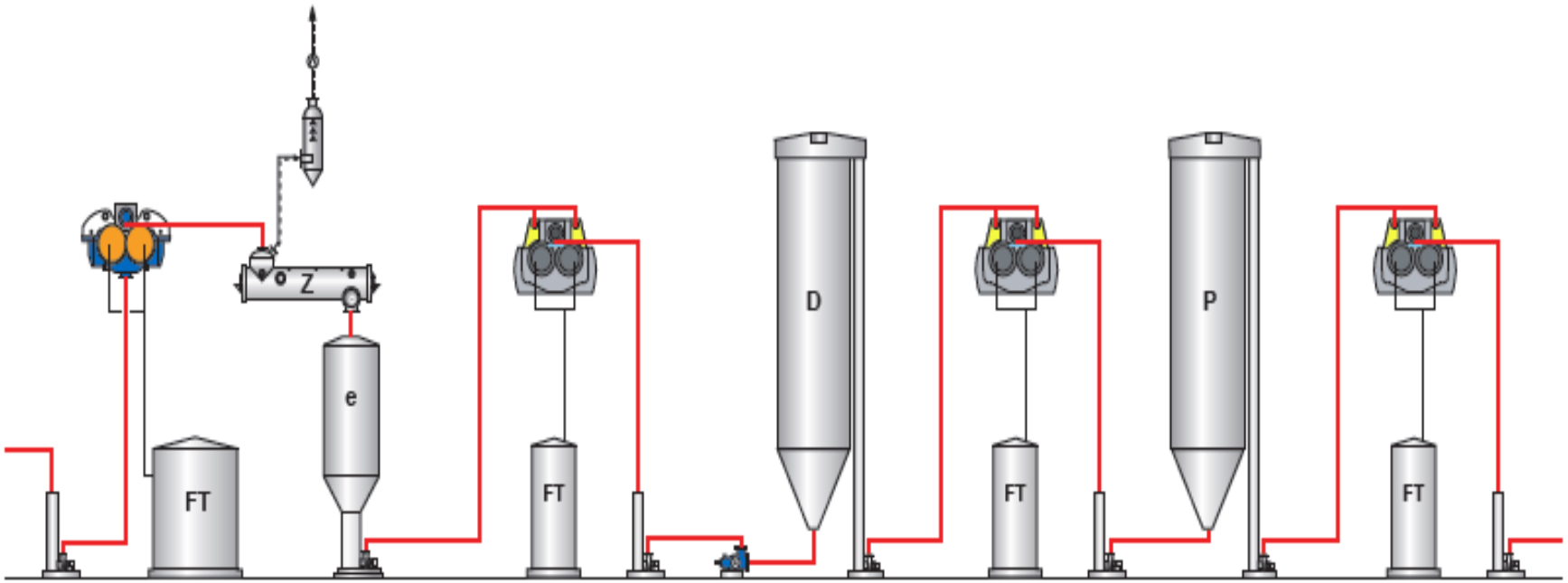


HC Ozone Bleaching



Courtesy of Valmet ©

Typical Ze-D-P bleach plant from Valmet©



Courtesy of Valmet ©

Lower Environmental Impact

Effluent volume and load

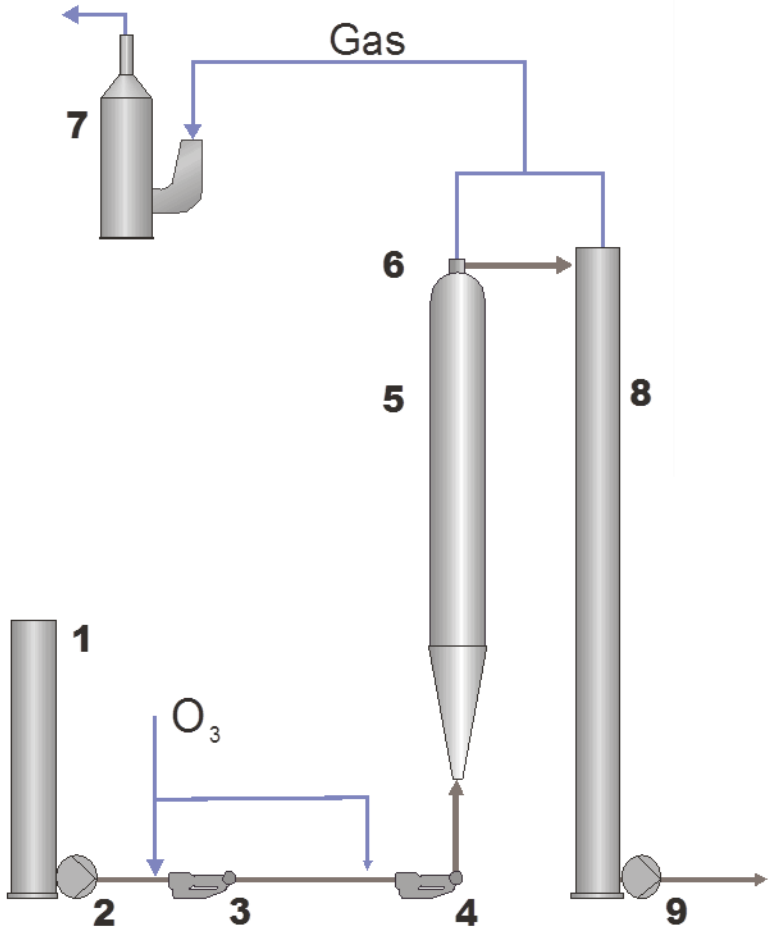
-Lower effluent volume with HC ozone

Press based bleach plant	D_{ht}(EOP)DD	(Ze)DP
Effluent volume, m^3/odt	11-12	5-10
COD, kg/odt	28	12-22*
AOX, kg/odt	0.4	< 0.1
Color, kg/odt	13	7-11*

**Variation depends on how much (Ze)-filtrate is recycled to POW*

Source: "Follow-up and Highlights of Today", Maria Wennerström, 3rd ZeTrac Forum, 2011

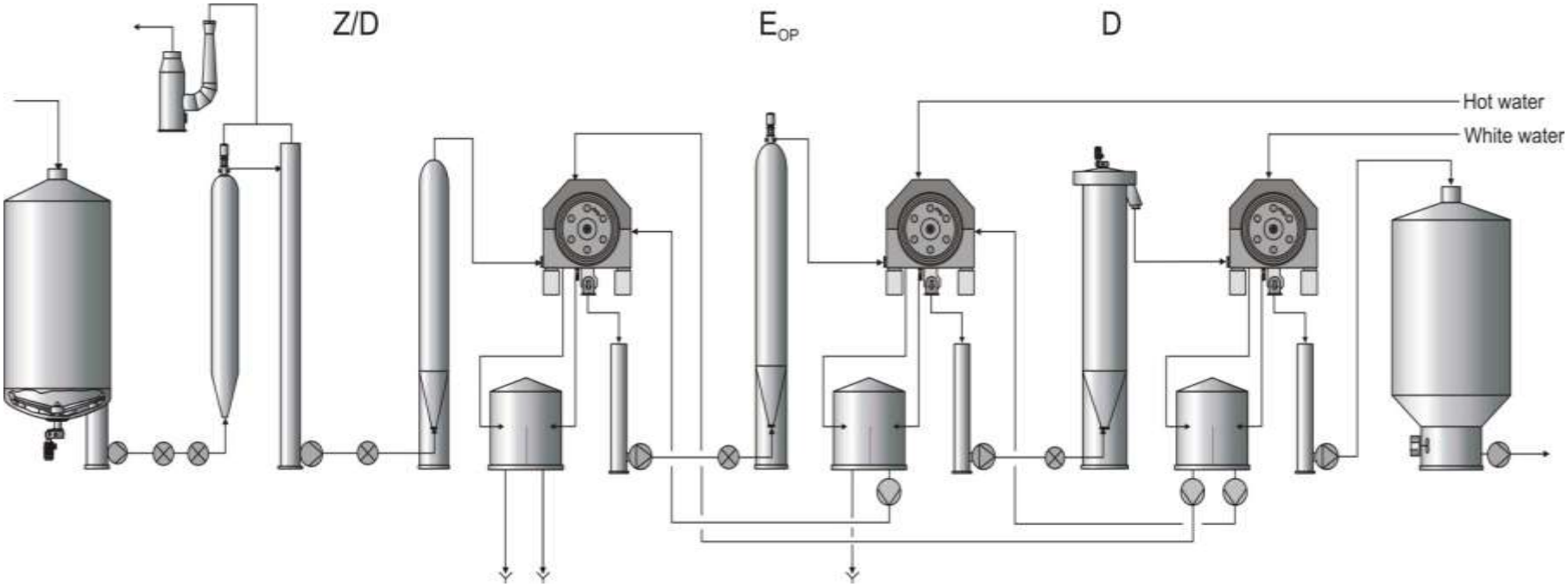
MC Ozone Bleaching



Courtesy of ANDRITZ

1. Dropleg
2. MC-pump
3. AZ ozone mixer
4. AZ ozone mixer
5. Ozone reactor
6. Reactor discharger with gas removal
7. Fiber scrubber
8. MC blow tube
9. MC-pump

Typical ZD-Eop-D bleach plant from ANDRITZ



Courtesy of ANDRITZ

Typical ZD-Eop-D bleach plant from ANDRITZ

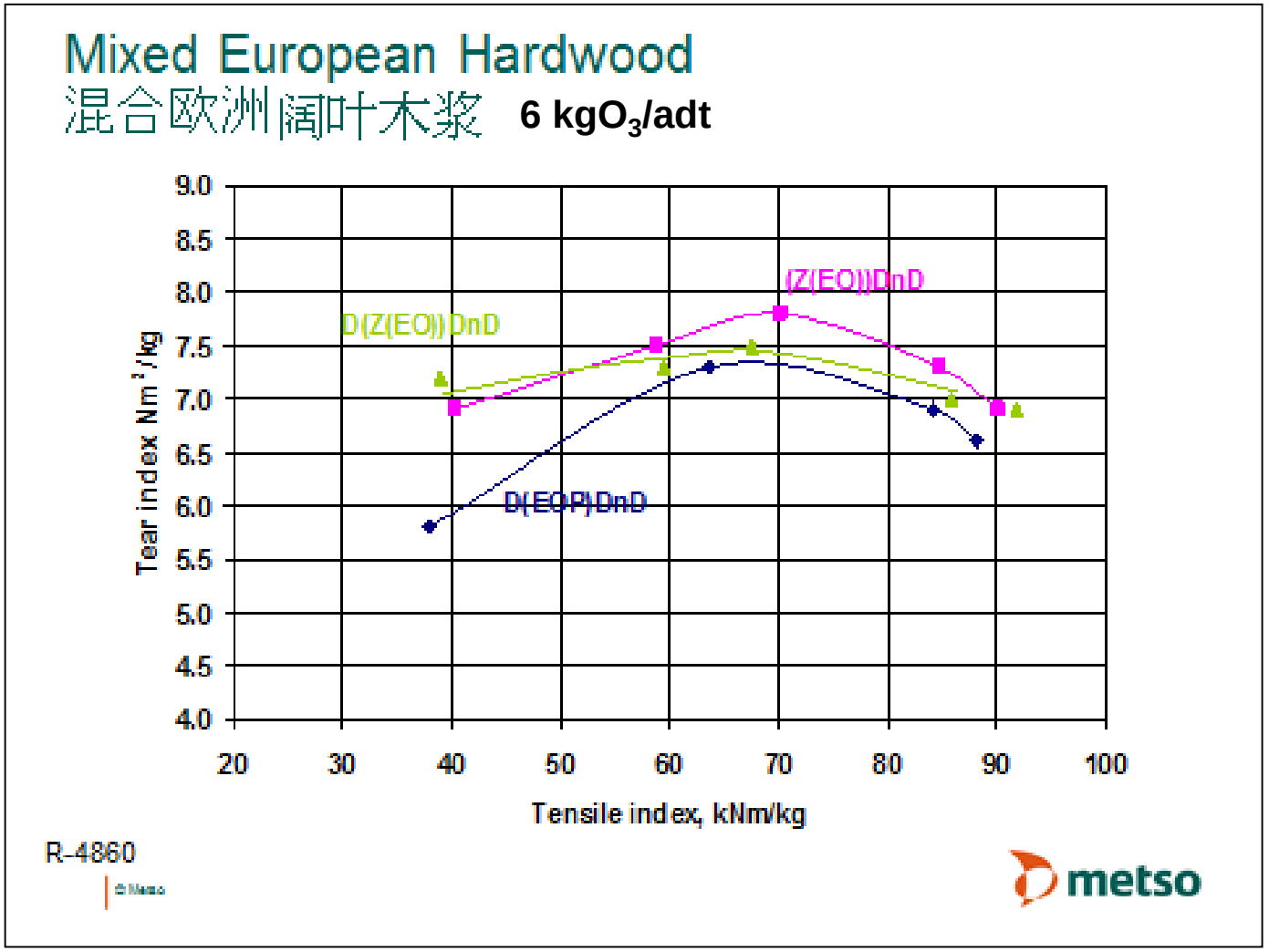
Pulp final brightness	**90 % ISO**
ClO2, act Cl	**15 kg/adt**
NaOH	**9 kg/adt**
O3	**5 kg/adt**
H2O2	**3 kg/adt**

Effluent values:

COD	**22 kg/adt**
AOX	**<0.15 kg/adt**
Volume	**12 m3/adt**
Colour	**< 5 kg Pt/adt**

RAMARK, H, Bleaching of Pulp with an MC Ozone Stage, Proceedings of China Paper 2012 Conference, Shanghai

Excellent Pulp Quality



Source: "ZeTrac Ozone Bleaching – Environmental and Cost Benefits", Yutong Feng, China Paper 2012

Economics

I. Conversion factors to oxidation equivalents, OXE

	Molecular weight	*e^-/mol for reduction to Cl^- and O^{2-}, resp.*	*g/mol e*	*OXE/kg*
Cl_2	70.914	2	35.46	28.20
ClO_2	67.457	5	13.49[a]	74.12[b]
NaClO	74.448	2	37.22[a]	26.86[b]
O_2	32.000	4	8.00	125.00
H_2O_2	34.018	2	17.01	58.79
O_3	48.000	6	8.00	125.00

[a] = 35.46 g active chlorine/mol e^-
[b] = 28.20 OXE/kg active chlorine

125 / 74.12 = 1.7
Each kg ozone replaces 1.7 kg chlorine dioxide.

Source: "Oxidation Equivalents, OXE, an Alternative To Active Chlorine", Roland Grundelius, Vol. 76, No. 1, TAPPI Journal

Economics

Chlorine dioxide Cost: 115 INR/kg

Power Cost : 7 INR/kWh
Oxygen Cost : 8 INR/kg

1 kg Ozone requires 10 kWh and 8.3 kg Oxygen

therefore

1 kg Ozone costs (10 x 7) + (8.3 x 8)
=
136.4 INR/kg

Additional power of 1.5kW/kg ozone is required for compression for MC bleaching

136.4 + 7x1.5 = 146.9 INR/kg ozone compressed

Economics

A 5 kg/adt O_3Dose would replace 8.5kg pure ClO_2

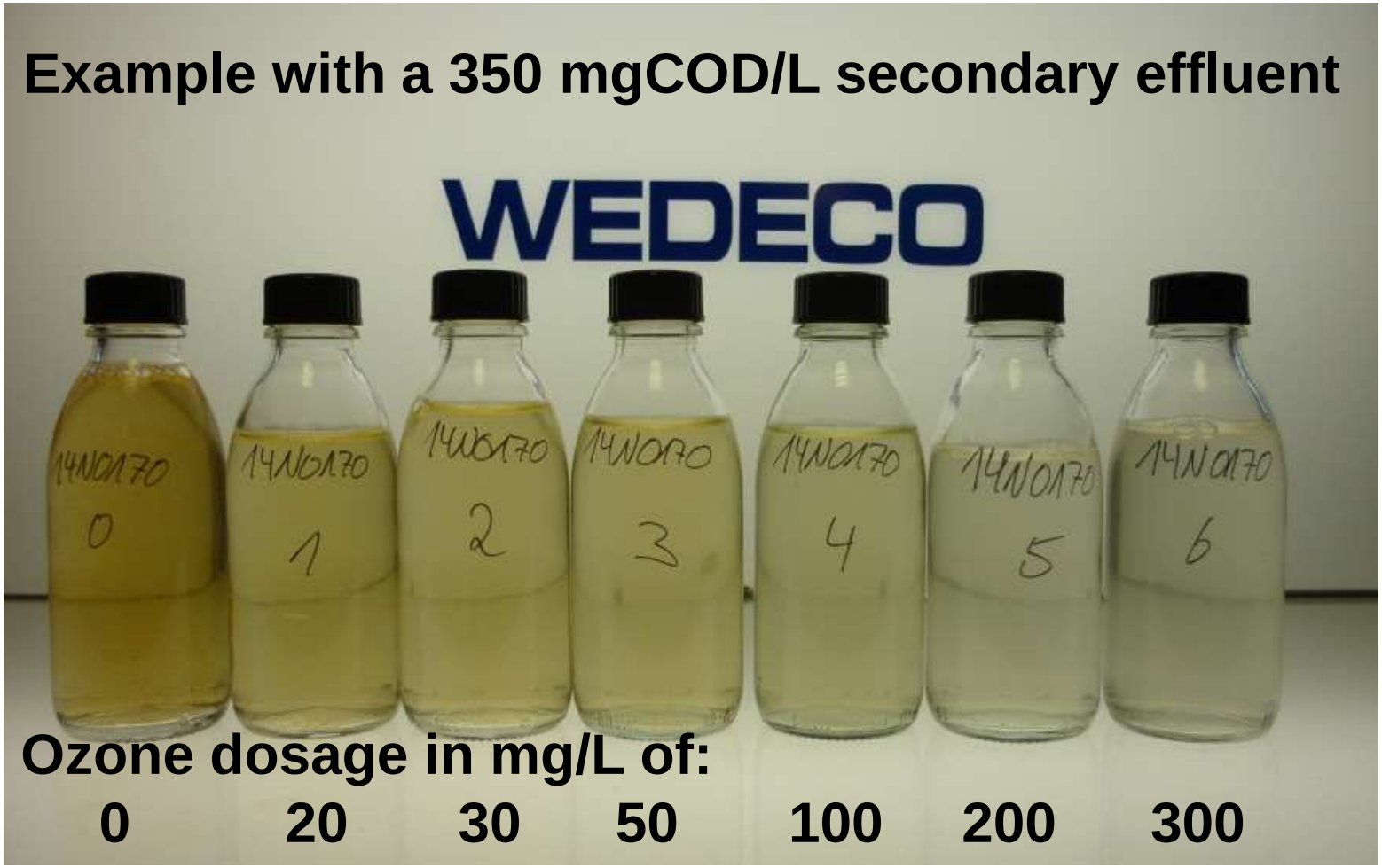
(5 x1.7 x115)ClO_2 - (5 x 146.9)O_3
=
243 INR/adt Chemical saving

243 x 1,000adt/day
=
243,000 INR/Day Savings.

Therefore

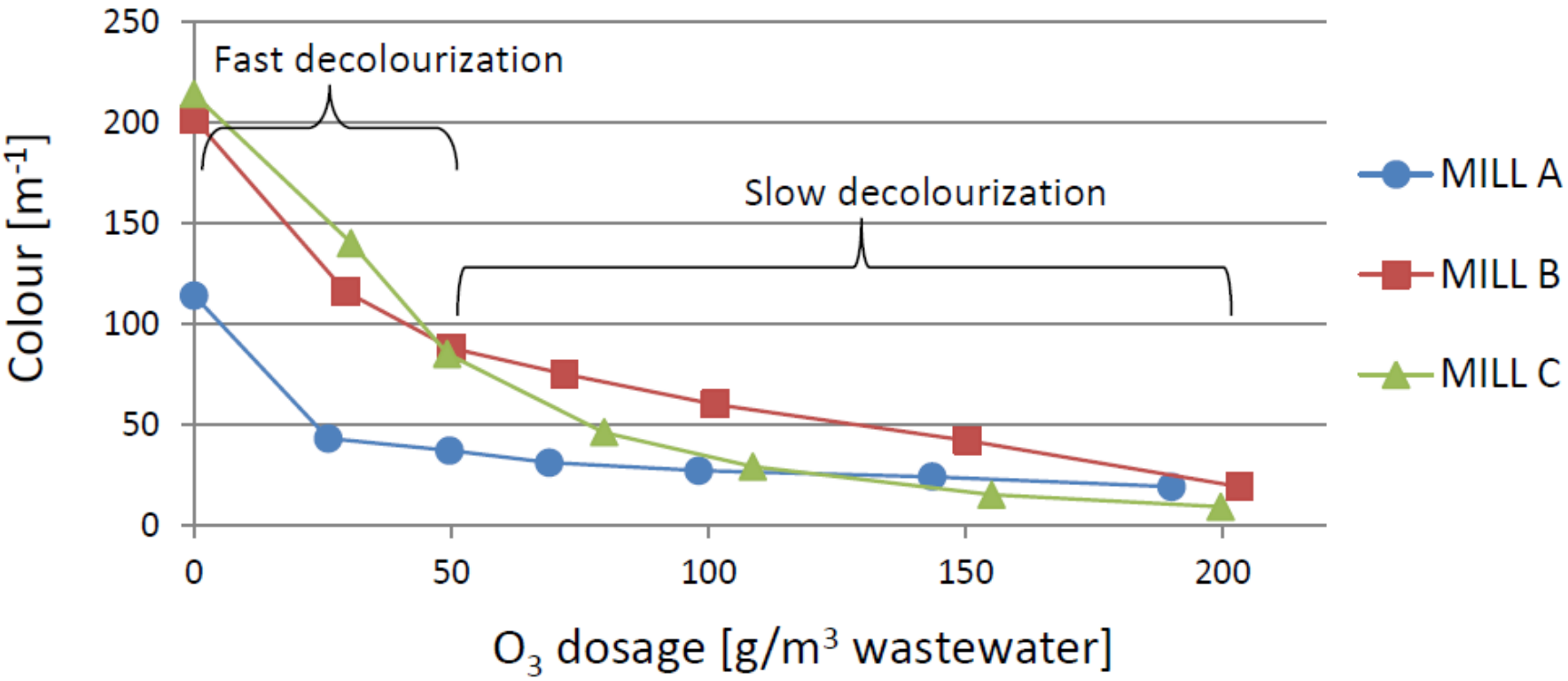
Considering Investment costs in a full ozone bleach stage ROI can be calculated at between 2 to 4 years

Color Removal in Final Effluent of Bleached Kraft Pulp Production



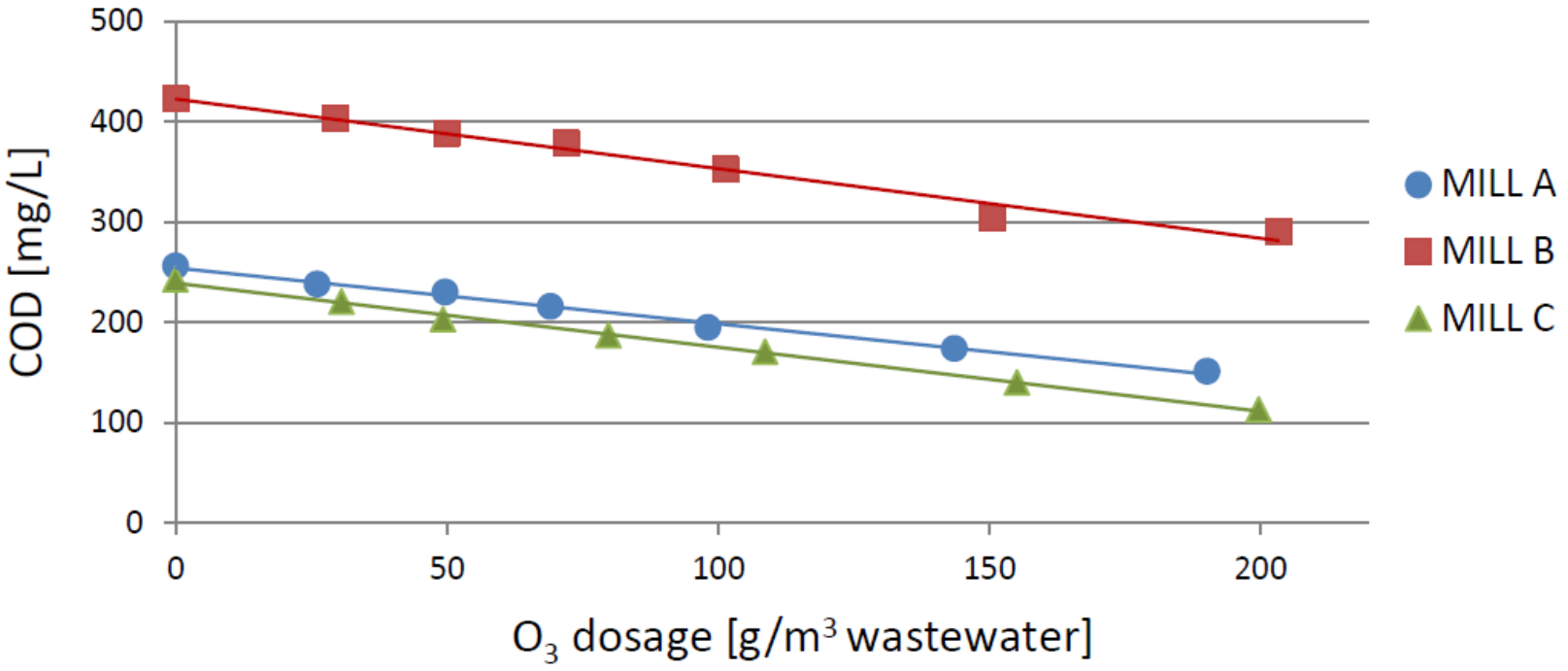
Ozone Action on Biological Effluent

Discoloration is the first noticeable phenomenon



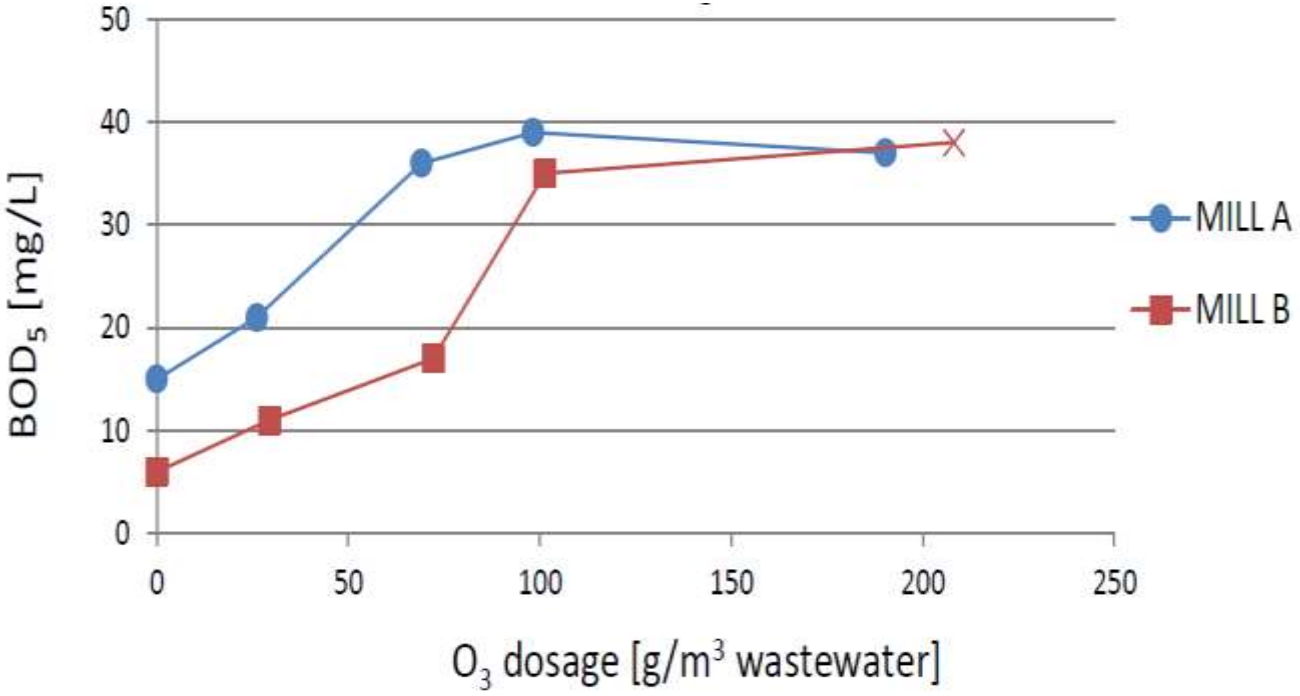
Ozone Action on Biological Effluent

Ozone reacts with hard COD



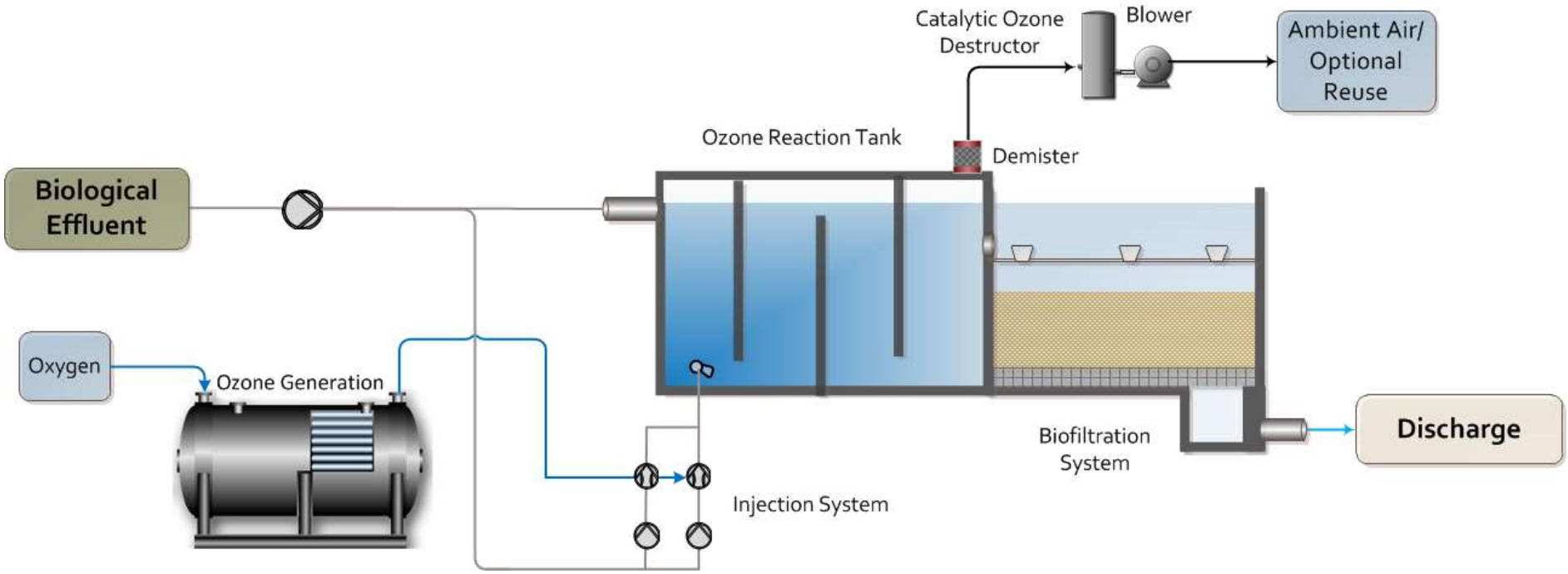
Ozone on Biological Effluent - BOD Increase

Part of the hard COD is converted to BOD.



It results in a an increase of the BOD/COD ratio and therefore of the effluent biodegradability.

Hard COD Removal in Final Effluent



3 installations in the PPI:

- **UPM Ettringen and UPM Plattling in Germany**
- **Heinzel Laakirchen in Austria.**

Filtration

LEOPOLD Ultrascreen for solid loading reduction and polishing

The Ultracreen® is a microfilter produced by Nuovoe Energie with a 20 micron SS 316L mesh and a SS 304 body that works on the tangential filtration principle. It has a plug and play design and could aid in final polishing for. It supports TSS and BOD reduction in tertiary applications. Has the highest loading capacity in the industry

LEOPOLD Conoscreen for solid recovery and loading reduction

The Conoscreen® is an extremely simple microfilter by Nuovoe Energie and is really efficient. It follows the "tangential filtration" principle. The feeding flow to the conical discs (where the filtering meshes are installed) occurs parallel to the filtration surface, differently to the other filters, where the filtration principle is of "deep- type " and orthogonal to the flow. All SS304 body. Mesh size of 250 and 500 micron

LEOPOLD TYPE XA™ & TYPE S® FAMILY OF UNDERDRAIN

Underdrain is used to support media during filtration and to uniformly distribute backwash air and water when the filtration media needs to be cleaned. Leopold has designed a water recovery channel into its Type S® technology underdrain to help ensure uniform and continuous airflow from all of the top deck orifices. The water recovery channel is designed to allow water to re-enter the underdrain to equalize the low-pressure areas. The results of Type S technology are:

- Airflow range is 1 to 5 scfm/sf
- Low water maldistribution – less than 5 percent (total)

LEOPOLD
a xylem brand

Conclusions

For a mill using ECF bleaching looking to improve their environmental impact while increasing production, the Best Available Technology is the installation of an Ozone (Z)stage in the bleach plant, this will:

- **Reduce effluent volumes**
- **Reduce COD loads**
- **Improve Colour**
- **Reduce AOX**

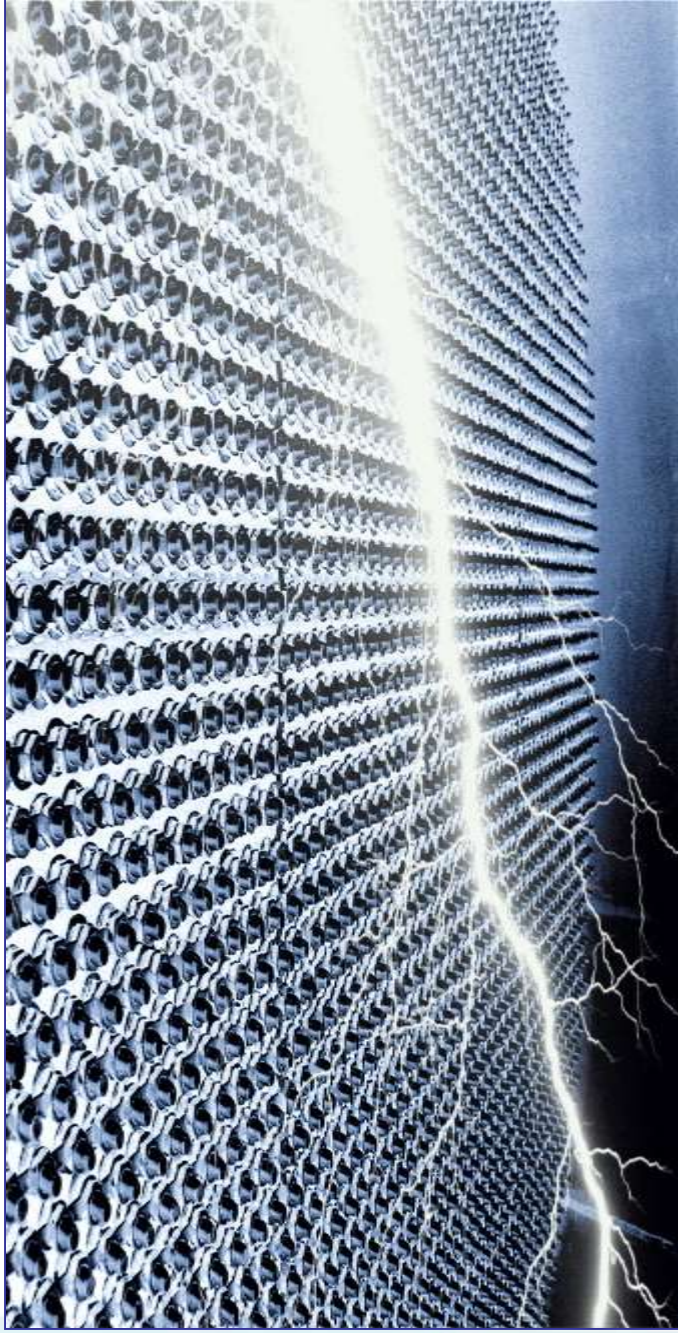
While

- **Reducing chemical costs**
- **Improving pulp quality**

Sustainable development is your ambition…

Ozone bleaching is our solution!

Fibria Jacarei, Brazil



Thank you for your attention!