THE SCIENCE OF A PURE ENVIRONMENT

Certified ISO9001

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PRESENTATION OF CONDENSATE TREATMENT

THE CONDENSATE TREATMENT

The absence of impurities in feed water is basic to the efficient operations of high pressure boilers, nuclear reactors and steam generators. Under equilibrium conditions, impurities in the feed water are very low and consist of:

- *salts*
- *silica*
- *metal oxides in trace concentrations*

These are introduced into the cycle by:

- *make-up*
- *corrosion*
- *erosion*
- *very small condenser leaks*

THE CONDENSATE TREATMENT

Impurity levels in feed water are particularly high at initial plant start up, after forced or planned outages or during periods of condenser water in-leakage caused by tube ruptures.

Condensate polishing is the way to solve eventual problems and demonstrates cost effectiveness through:

THE CONDENSATE TREATMENT

1) much faster initial plant start up;
2) rapid restart to full load after outages;
3) continued on line operation during small condenser leaks occurs;
4) increased turbine efficiencies due to minor silica deposition;
5) prolonged turbine life caused by elimination of sodium, chloride and sulphate stress corrosion and cracking;
6) substantial energy saving due to blow-down reduction;
7) lower chemical, neutralisation and waste treatment costs due to lowed feed water make up demand;
8) reduced consumption of conditioning chemicals;
9) longer time between turnarounds for boiler acid cleaning.

TYPE OF CONDENSATE TREATMENT SYSTEM

The design of condensate polishing system will be influenced by:

steam cycles,
site conditions,
space considerations,
cooling water availability and temperature,
material of construction used in condensers,
pumps,
ancillary equipments,
piping,
lastly by engineering requirements by the Client.

TYPE OF CONDENSATE TREATMENT SYSTEM

The most widely used design, all proposed by IDRECO are:

- precoat filter demineralizers of the DECOREX® type, using powdered ion exchange resins for simultaneous removal of dissolved and suspended solids;
- high rate bead type cationic units followed by high rate bead type mixed bed demineralizers;
- high rate mixed bed alone or in combination with DECOREX® type precoat filter demineralizers.

The DECOREX® filter demineralizers is a proprietary IDRECO design

THE DECOREX PROCESS

In the DECOREX® process, finely powdered Suprex® ion exchange resins are used as precoat media to exchange dissolved ionic species, remove suspended particulate matter, organics, non-reactive silica and colloidal matter.

The process has been also used to remove such contaminants in the production of ultrapure condensate for feed water to high pressure nuclear and fossil-fired boilers.

THE DECOREX PROCESS

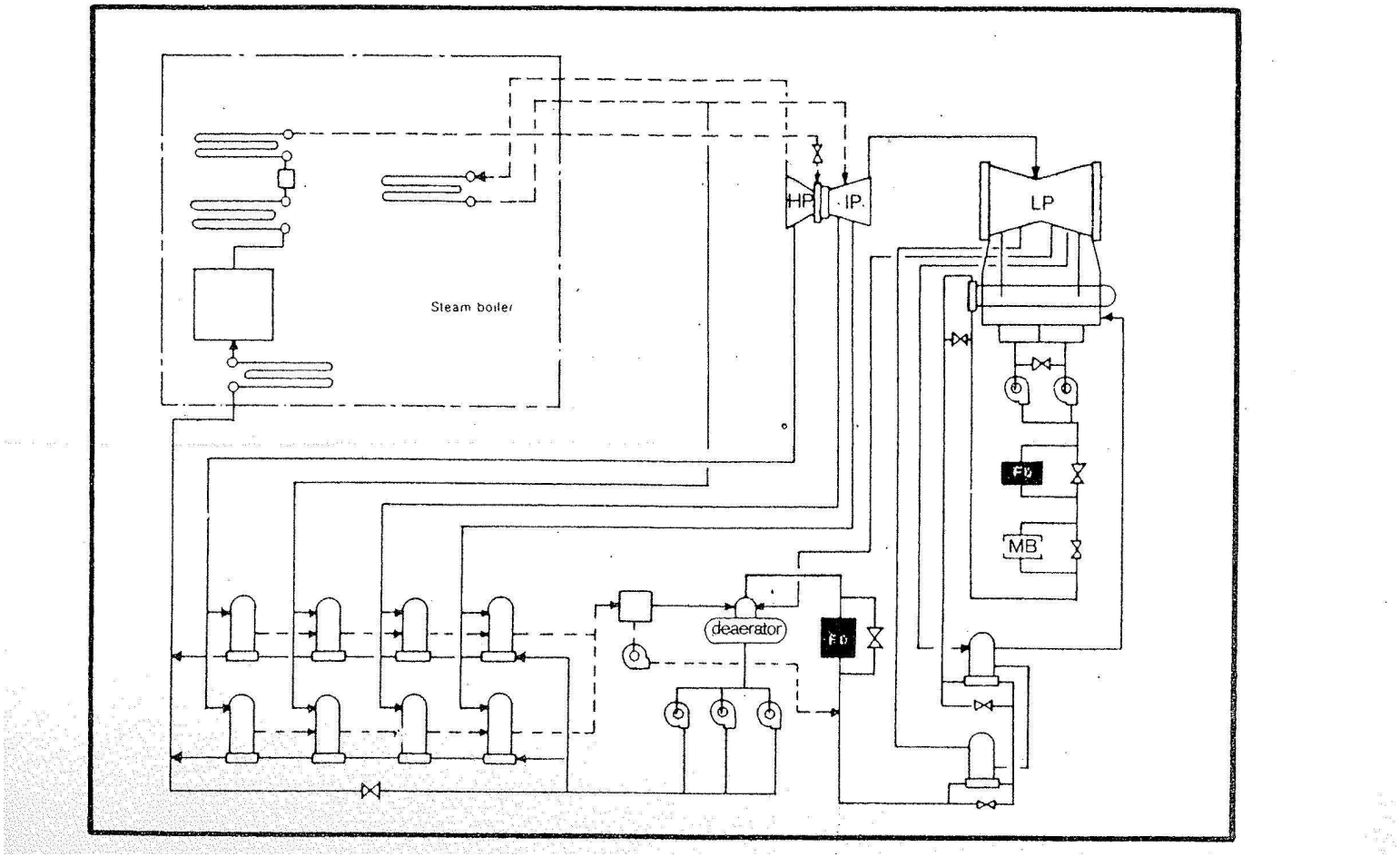


Figure: Location of condensate polishing system in a fossil fired high pressure power station

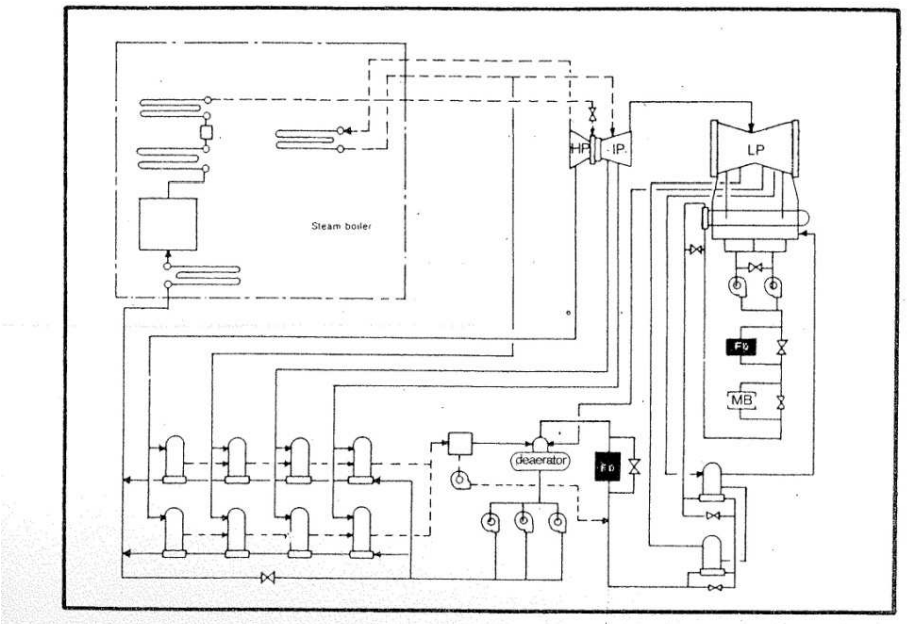
THE DECOREX PROCESS

Filtration takes place in depth through the entire mass of the precoat and not simply by the thin surface layer.

Crud retention and ion exchange capacity are thus increased and run lengths are greatly extended.

It is important to underline that all the phases will take place at very low pressure drop.

Normally the differential pressure across the filtering elements is less than 2 psi at design flow.



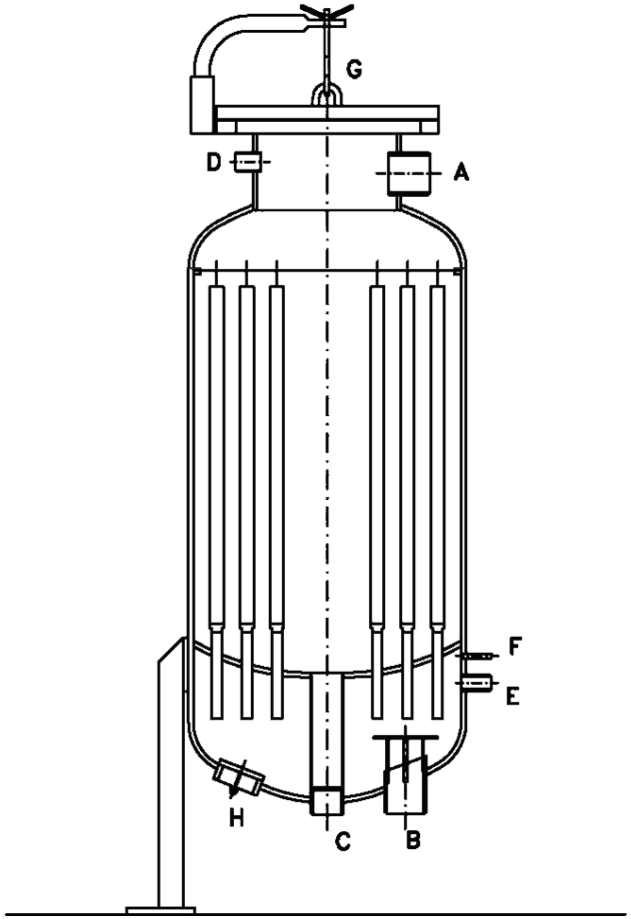
THE DECOREX PROCESS

The DECOREX® filter consists of a pressure vessel equipped with tubular filter elements installed vertically on a support plate.

Influent condensate enters in the filters from the top, passes through the precoated elements and collects under the support plate.

The effluent exits through a bottom connection.

A separate bottom drain is provided for backwashing spent precoat material.



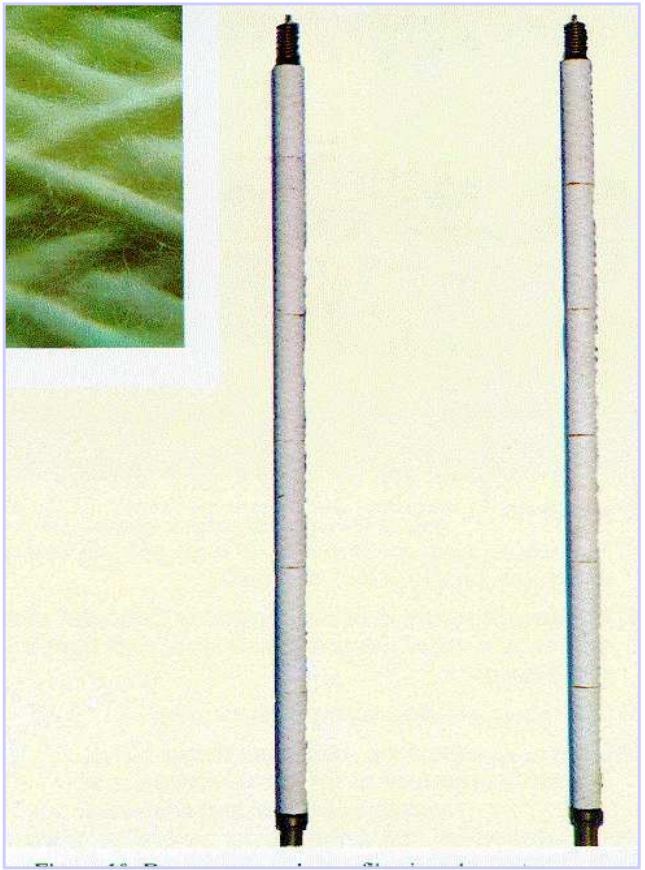
THE DECOREX PROCESS

Two types of filtering elements are available:

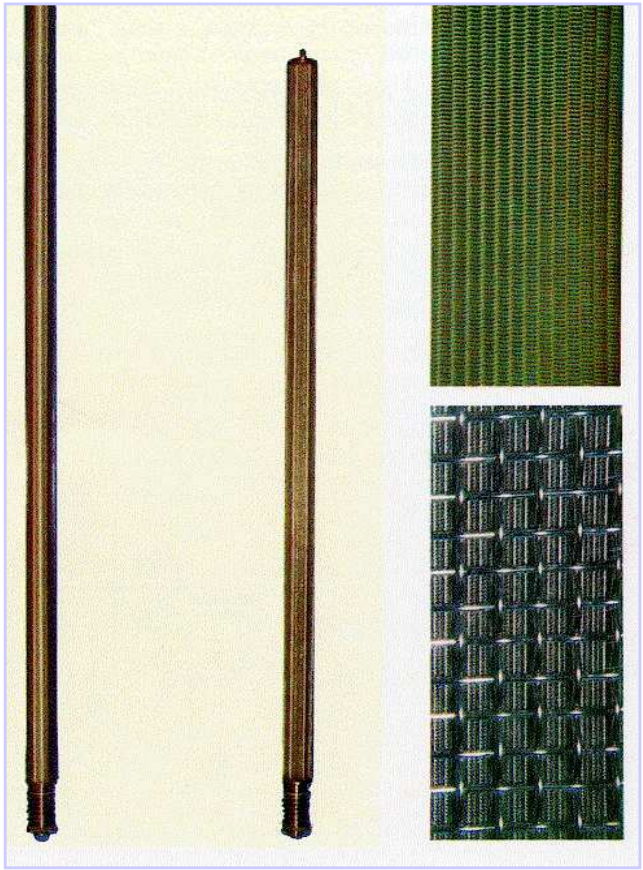
fiber type (wound polypropylene or nylon yarns) : usable until 140℃ maximum for the only removal of suspended solids.
This temperature limit falls to 115℃ in the case o f ion removal;

metal type (stainless steel septum) : showing no temperature limitation, specially used in condensate polishing for medium and high pressure industrial boilers, nuclear reactors and steam generators, fuel pools, radioactive waste and reactor water clean-up.

THE DECOREX PROCESS



FIBER FILTERING ELEMENTS



METAL FILTERING ELEMENTS

DECOREX ® wound yarn* and stainless steel filtering elements

THE DECOREX PROCESS

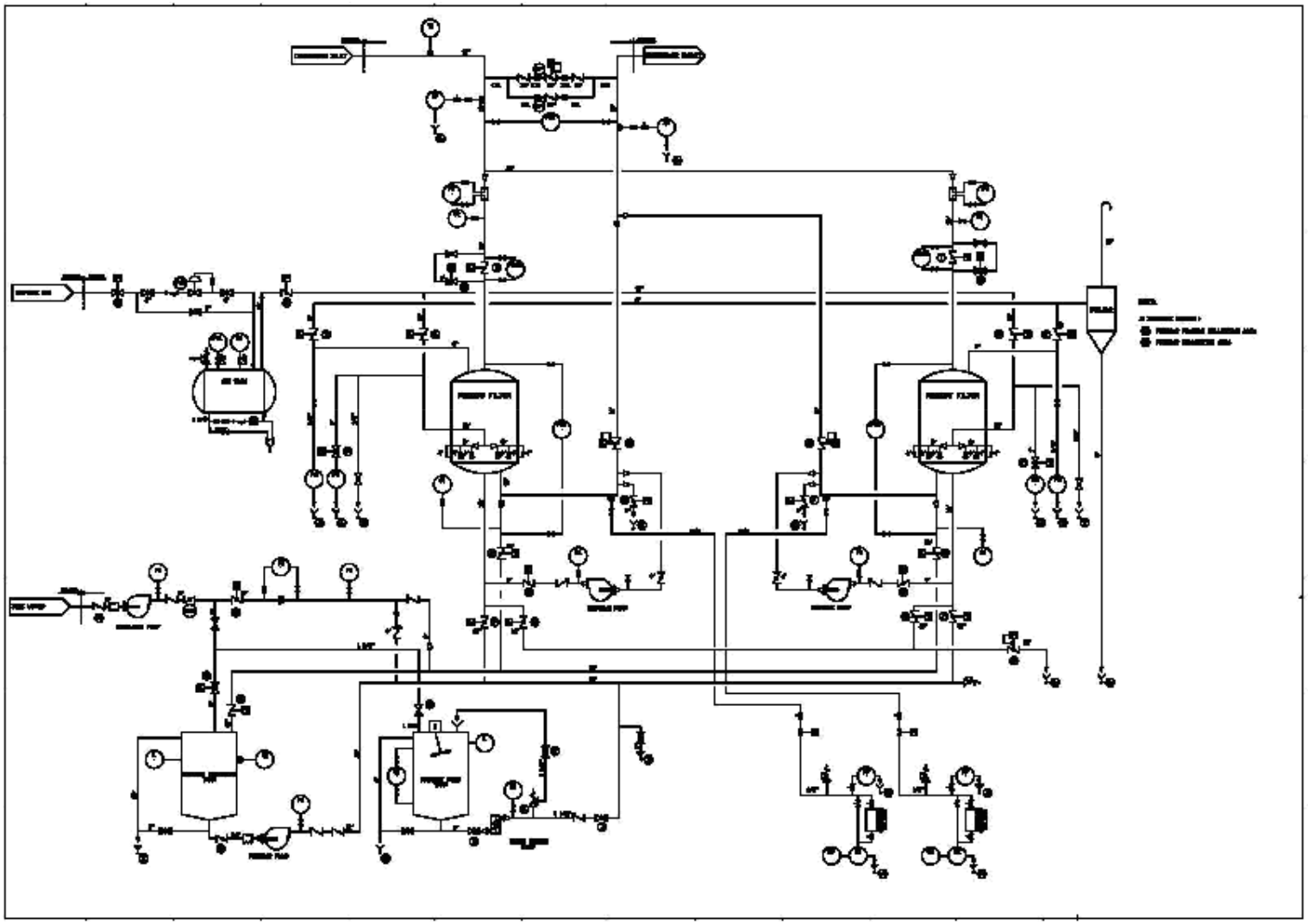


Figure: Typical DECOREX ® precoat filters P&ID

THE DECOREX PROCESS

The condensate polishing system can produce high purity effluents satisfying the following requirements:

- *TDS less than 10 ppb with the influent in the range of 20÷200 ppb*
- *with influent pH of 8,8÷9,6 and 300÷2000 ppb ammonia*
- *maximum sodium removal at high pH*
- *maximum removal of suspended or colloidal metal oxides and other contaminants under all operating conditions*
- *operation at minimum pressure drop*
- *optimum use of ion exchange resins for maximum impurities removal at lowest operation cost*

THE DECOREX PROCESS

How DECOREX® systems accomplish this:

- *Powdered resins are changed after every cycle. The polishing system always operates with new, fully regenerated resins.*
- *Powdered resin purity is higher than most bead resins. Powdered resins meets nuclear grade specifications.*
- *Powdered resins kinetics are extremely rapid. Finer mesh means more reactive surface available.*
- *Powdered resins are regenerated to 95÷99% of capacity, virtually impossible with deep beds, except for the first run.*
- *Powdered resins permit the variation of cationic and anionic ratios, difficult to accomplish with deep beds*

HIGH RATE MIXED BED PROCESSES

High rate mixed beds use bead resins type ion exchange to polish the condensate. Due to the large mass of resin, the exchange capacity is high. They are thus often used for sea water or brackish water cooled condensers where a leak could cause heavy condensate contamination.

In a typical unit, beds are 0,9÷1,2 m deep and flow velocity is around 120 m/h.

High rate mixed beds can be used alone, in combination with precoat filters or downstream of a cationic unit.

HIGH RATE MIXED BED PROCESSES

The cycle end occurs when the quality of the condensate outlet is not acceptable for the design conditions, as resin exchange capacity doesn't assure proper polishing. The critical parameters, controlled in the outlet streams (such as silica, conductivity and pH) are out of the requirements. The other parameter that oblige the end of cycle to start the cleaning phase is the pressure drop across the resin bed.

When one of the above causes occurs, the resin bed regeneration becomes necessary; it starts with the resin transfer in an external regeneration equipment where both separation, independent regeneration and final mixing will take place.

COMREC MIXED BED REGENERATION PROCESS

Cross-contamination of mixed bed resins always results in the presence of some sodium and chloride (or sulphate) ions in treated condensate. To minimize the presence of above ions in the treated condensate is imperative to perform a perfect separation of the two types of resins, to avoid having the cationic resin exhausted in sodium form and anionic resin exhausted in chloride or sulphate form. To perform the perfect resins separation, IDRECO introduced the COMREC processes.

COMREC MIXED BED REGENERATION PROCESS

These two processes separate anionic and cationic resin to a degree not reachable even using an inert beads layer as intermediate specific gravity. The COMREC processes depend on two key operations: firstly the hydraulic classification of mixed bed resins into lighter anionic and heavier cationic fraction within a single vessel; secondarily the mechanical isolation of the narrow interface zone in which anionic and cationic resins are inextricably mixed.

COMREC MIXED BED REGENERATION PROCESS

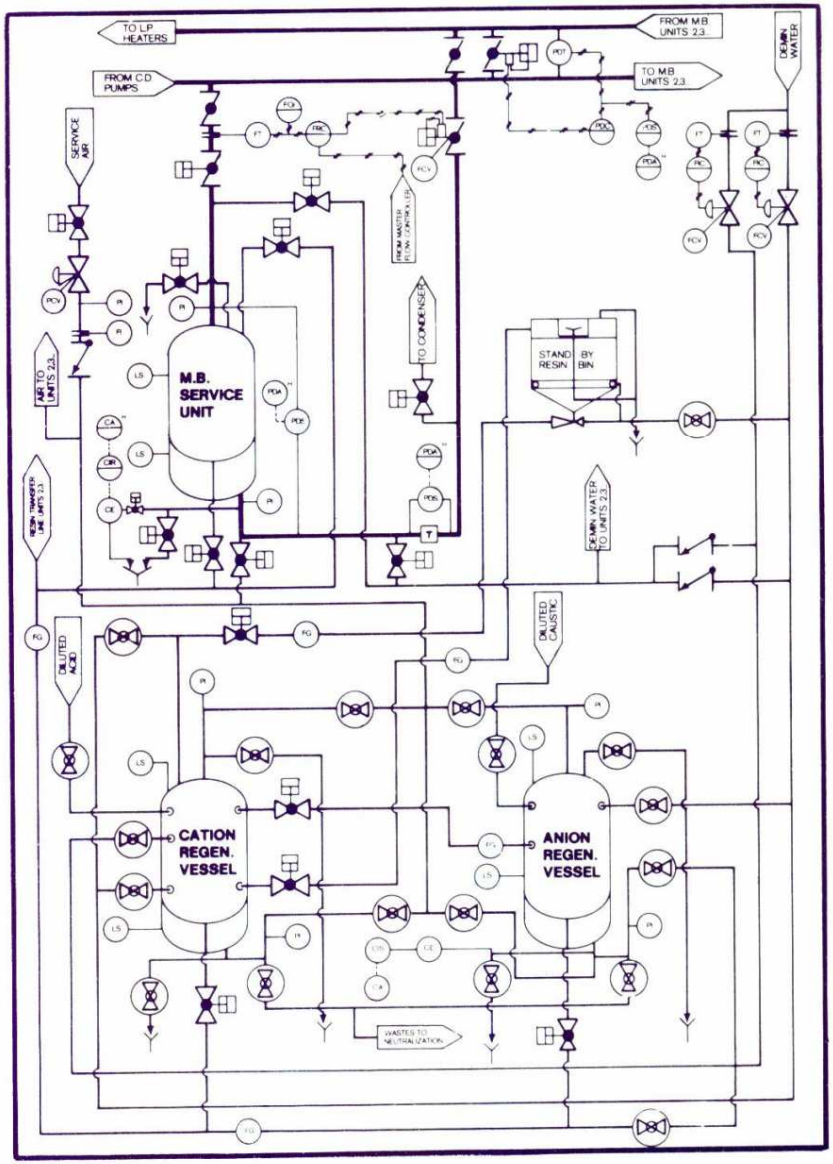
In the COMREC 1 process the resin separation takes place in the cationic regeneration vessel where the anionic resin and intermediate layer transfers are operated separately from two different nozzles in the cylindrical part of the vessel. The anionic resin is regenerated in its dedicated vessel where after the cationic regenerated resin is transferred for mixing. The interface layer, containing inseparable mixed resin, is transferred to a stand-by hopper, from which is then transferred to empty cationic regeneration vessel where it remains until a new batch of exhausted mixed resin arrives from processing.

COMREC MIXED BED REGENERATION PROCESS

In the COMREC 2 process the resin separation occurs in the anionic regeneration vessel where the cationic resin and intermediate layer transfers are operated separately from the same nozzle, located in the bottom head the vessel. By means of a conductivity control the intermediate layer is separate from the cationic resin, which is regenerated in its dedicated vessel.

The interface layer is operated as per COMREC 1.

COMREC MIXED BED REGENERATION PROCESS



In some cases, the external regeneration system includes a holding tank where the cationic and anionic freshly regenerated are transferred for mixing and final washing.

COMREC MIXED BED REGENERATION PROCESS

Removal of crud with DECOREX® and high rate mixed bed condensate polishing system with COMREC regeneration system. Actual operating data unit in ppb.

Polisher Type	Boiler Type	Iron (total)		Copper (total)	
		Inlet	Outlet	Inlet	Outlet
DB	BWR	36	9,7	10	2,6
DB	O.Th.	60	25	5	2,2
DB	Drum	40	6,0	4,3	0,3
PRF	BWR	14	0,6	1,3	0,2
PRF	O.Th.	17	0,6	0,2	Trace
PRF	PWR	57	1,0	1,1	0,2

DB = Deep Bed Demineralizer; PRF = Powdered Resin Filter Demineralizer; O.Th. = Once Through Boiler; Drum = Drum Type Boiler; PWR = Pressurized Water Reactor; BWR = Boiling Water Reactor

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COMREC MIXED BED REGENERATION PROCESS

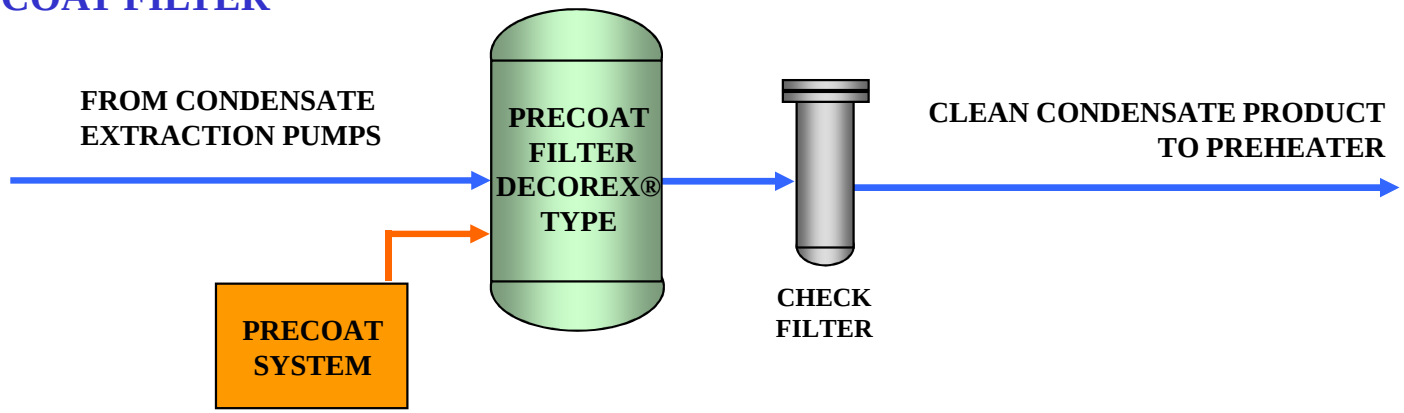
Removal of crud with DECOREX® and high rate mixed bed condensate polishing system with COMREC regeneration system. Actual operating data unit in ppb.

Polisher type	Boiler type	Sodium		Sulphate		Chloride	
		Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
DB	O.Th.	1	0,1	0,4	0,05	0,6	0,3
DB	Drum	0,7	0,02	2,2	1	0,3	0,3
DB	PWR	0,06	0,04	0,8	0,4	0,12	0,06
PRF	Drum	0,5	0,2	1,5	0,7	0,04	Trace
DB	BWR.	2,1	0,4	1,8	1,7	1,5	1,2
PRF	O.Th.	0,8	0,5	0,4	0,1	0,3	0,1

DB = Deep Bed Demineralizer; PRF = Powdered Resin Filter Demineralizer; O.Th. = Once Through Boiler; Drum = Drum Type Boiler; PWR = Pressurized Water Reactor; BWR = Boiling Water Reactor

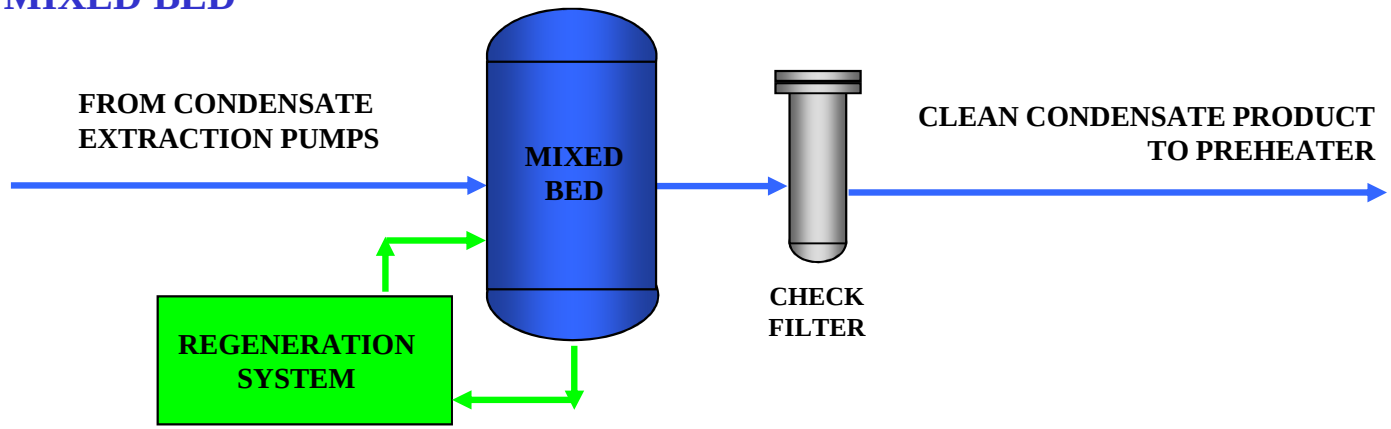
COMREC MIXED BED REGENERATION PROCESS

ONLY PRECOAT FILTER

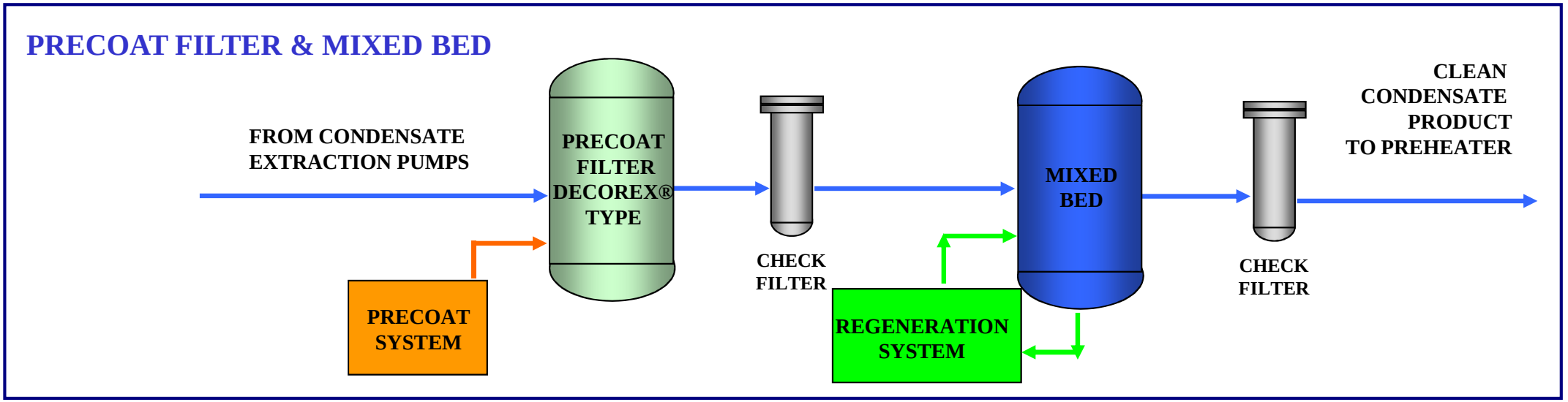


COMREC MIXED BED REGENERATION PROCESS

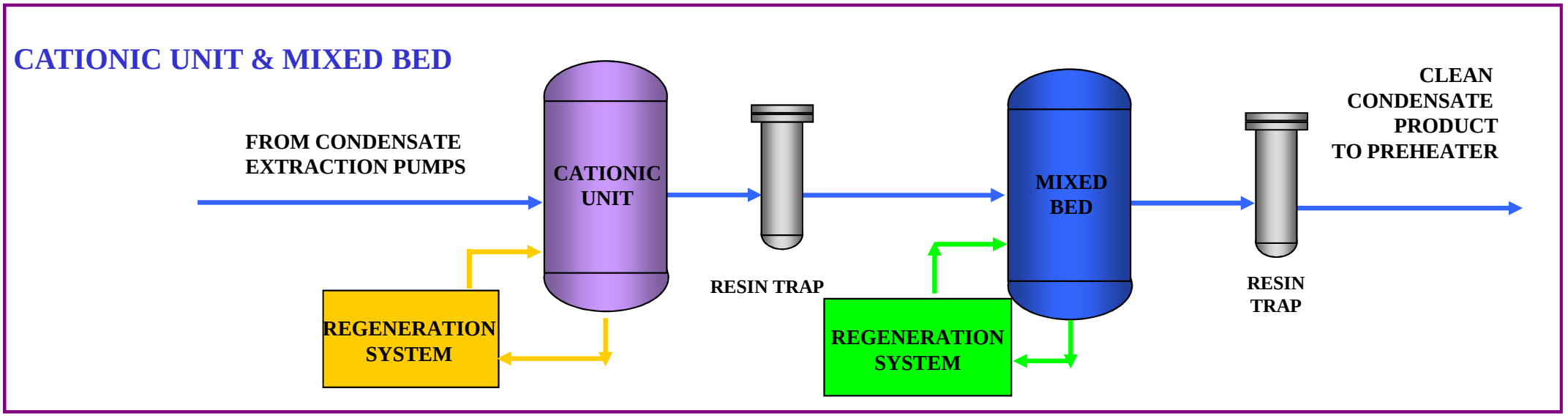
ONLY MIXED BED



COMREC MIXED BED REGENERATION PROCESS



COMREC MIXED BED REGENERATION PROCESS



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Thank you !

STATE OF THE ART TECHNOLOGIES FOR POWER PLANT