DESIGN OF DEEP-BED ION EXCHANGE CONDENSATE POLISHER INTERNALS

ASME RESEARCH COMMITTEE ON POWER PLANT AND ENVIRONMENTAL CHEMISTRY

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PRESENTED BY
KEN PANDYA
AWTS, INC
1817 TRIPLE CROWN LN
PLANO, TX 75093
OFFICE: 972 733 4404
EMAIL: pandyaken@aol.com

MOST COMMON DESIGNS OF DEEP BED IX CONDENSATE POLISHERS

- EXTERNAL REGENERATION
  – Condensate polisher vessel only holds regenerated ion exchange resin. Upon exhaustion, resin has to be sluiced out of the vessel to a regeneration station. Most of the condensate polisher vessels are at least furnished with air scour mechanism. After regeneration is completed, the resin is transferred back to the condensate polisher vessel.
- IN-SITU REGENERATION
  – Condensate Polisher Vessel holds a batch of ion exchange resin which upon exhaustion is regenerated, in place with a batch of regen chemical. The regeneration steps typically include either air or surface wash, backwash, regen , slow rinse and fast rinse steps.

WHAT IS SO SPECIAL ABOUT CONDENSATE POLISHER INTERNALS

- Typical Condensate Polisher vessels are processing extremely high flow rates
  - Conventional ion exchange vessels are designed for 6-10 gpm/square foot; condensate polishers can be designed for 35-40 gpm/square foot
- Condensate polishers also have to deal with suspended solids (Typically, rust), so most of these units have air scour mechanism
- Chemical regeneration flow rates can be extremely low, in comparison to the service water flow rate- in some cases 1:50 ratio of Chemical Flow rate Vs. Service water flow rate. This can lead to severe channeling problems
- Many customers do not have extra resources or space for external regeneration facility- which means, the condensate polisher vessel may also have to double up as a regeneration vessel.
- Because of limited space inside the condensate polisher, design of internals can be challenging
- Because of high-temp operation, we cannot consider plastic (PVC, CPVC designs.

MOST COMMON PROBLEMS WITH CONDENSATE POLISHER INTERNALS

- Resin loss, either during backwash or due to bad underdrain screens or broken laterals or damaged header components. It takes 0.015” opening ANYWHERE in the underdrain system to allow passage of resin into bulk stream
- Improper or inadequate support of the headers and laterals
- Underdrain screens coming apart, which allows resin to exit through bottom outlet
  - Some of the older designs require four or five parts for making up ONE screen assembly- there can be hundreds of such assemblies within one system
  - Some of the older designs incorporate wire mesh screens which can be easily clogged or damaged.
- Partial or complete plugging of orifices or screen openings inside the chemical laterals and air scour laterals
- Poor distribution, causing channeling, improper regeneration or poor operating efficiencies

RESIN FOUND IN CONDENSATE PIPING SYSTEM DUE TO LEAKY INTERNALS

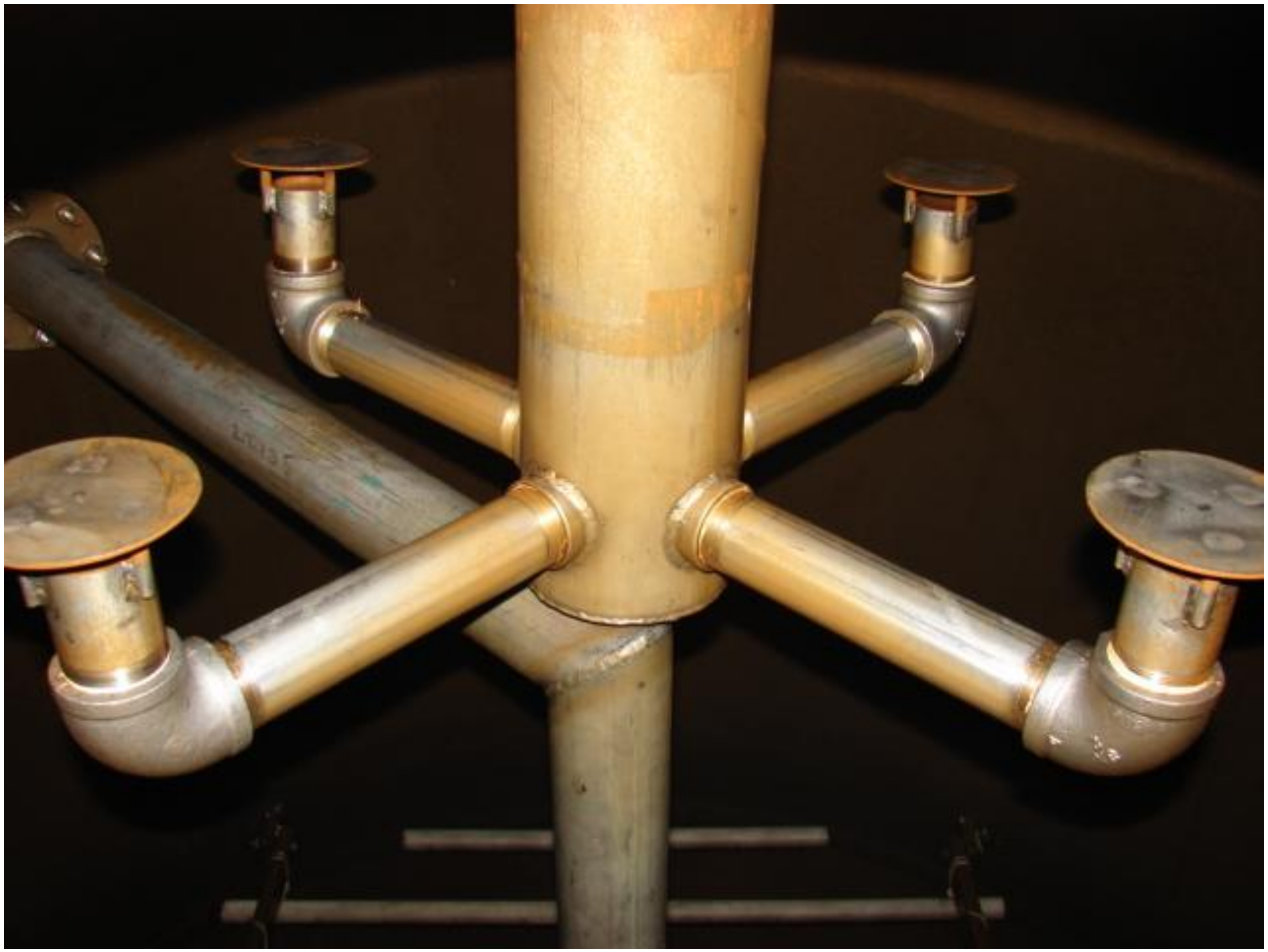
MOST COMMON DESIGN OF CONDENSATE POLISHER INTERNALS (1)

- Inlet Distributors
  - Header-lateral type with riser pipes. Consider furnishing Johnson type wedge wire screens with 0.012” slot size to prevent loss of resin during backwash
  - Hub-radial type (Not recommended for vessels over 5’ Diameter)
  - Splash Plate type (Worst distribution)
- Chemical Distributors
  - Header-lateral type, with drilled orifices to distribute chemical flow. Consider pipe base laterals with Johnson type screen jackets, 0.008” slot size. Avoid wire-mesh screens
- Air scour or surface wash distributors
  - Header-lateral type, with drilled orifices to distribute chemical flow. Consider pipe base laterals with Johnson type screen jackets, 0.008” slot size. Avoid wire-mesh screens
  - Some older designs with hub-radial type curved distributors, radial pipe that follow bottom curve of the vessel (Difficult to replace with other internals in place)

MOST COMMON DESIGNS OF CONDENSATE POLISHER INTERNALS (2)

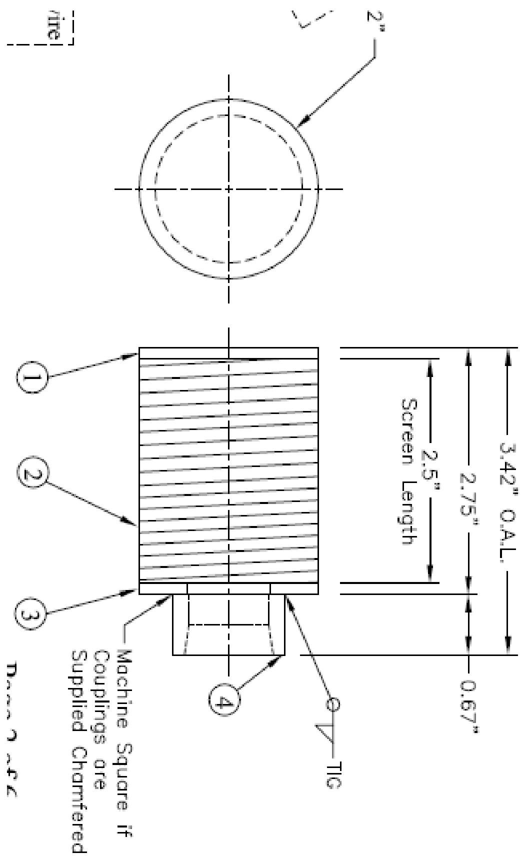
- Underdrain Distributors
  - This is the most critical part of the Condensate Polisher Internal distribution system- design has to consider several flow rate factors and considerable movement of resin. Failure of underdrain means disaster.
  - Header-lateral type with Johnson type screen nozzles, 0.008” slot size. Nozzles follow contour of the bottom head, within 2-3” clearance
  - Header-lateral type, with pipe base laterals and screen jackets, 0.008” slot size
  - Neva-clog type, perforated plate in sections. The whole underdrain plate has to be supported with special underdrain support system
  - Flat false bottom plate with openings to accept screen nozzles with “T” bolt clamps
  - Hub-radial type with wire-mesh screen to prevent resin loss (Not recommended)

INLET DISTRIBUTOR, SPLASH PLATE TYPE



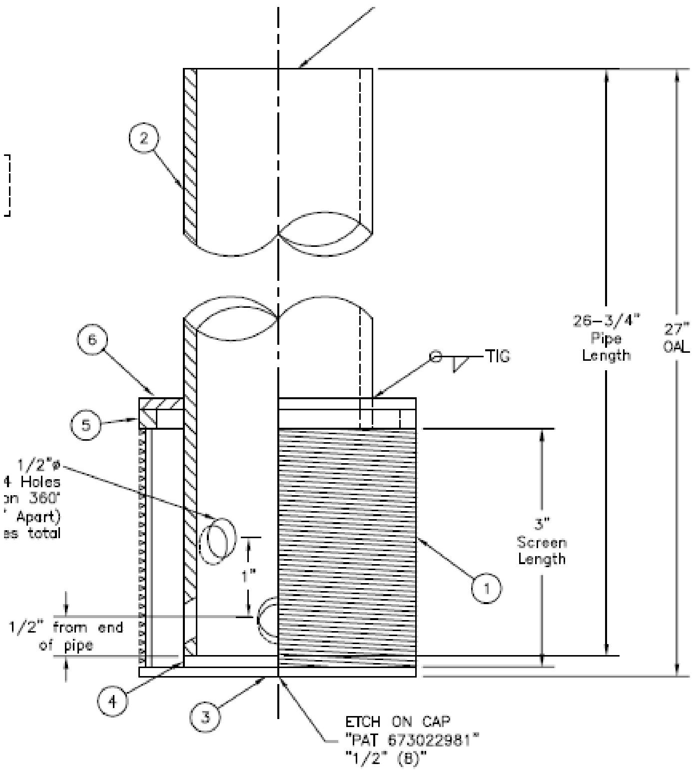
TYPICAL INTERNAL DISTRIBUTON HEADERS

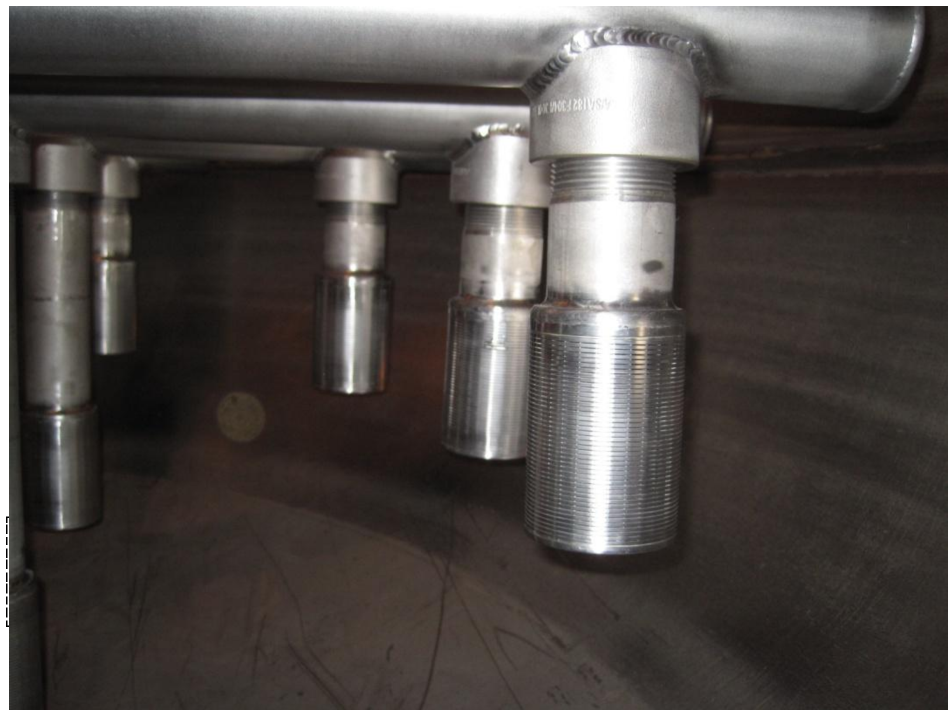
DRAWINGS AND PICTURES
INLET DISTRIBUTOR WITH SCREEN



CHEMICAL DISTRIBUTOR: HEADER WITH PIPE BASED SCREENED LATERALS

UNDERDRAIN DISTRIBUTOR WITH SCREEN NOZZLES





UNDERDRAIN SCREEN DURING FABRICATION (AWTS PATENT)

UNDERDRAIN HEADER, LATERALS AND DROP SCREENS

EXTERNAL RESIN TRAP

CERTAIN DO'S AND DON'TS (1)

- Do's:
  - Employ the best materials (Sch. 40, 316L, Seamless) and qualified welding procedures.
  - For the branch connections, consider 3000-lb couplings, full-penetration welds
  - Consider installing Johnson type screen nozzle on the inlet distributor and underdrain distributor.
  - Consider header-lateral type design for inlet, chemical, air scour and underdrain- particularly if the vessel is 5' Dia and bigger.
  - Consider installing an external resin trap in the service water outlet line.
  - Carry out regular inspections, to make sure that there are no loose parts
  - Take extra time and effort to evaluate and design the supports system, which may include special support clips, support bars, double-locking nuts

CERTAIN DO'S AND DON'TS (2)

- Don't:
  - Use wire-mesh screens. They will get clogged up easily with broken resin beads or debris, and cause serious problems leading to channeling, poor regeneration and early termination of service cycles
  - Avoid splash plates or hub-radial designs. Particularly for larger vessels- they are some of the most inefficient designs, although least expensive
  - Use inferior material, particularly lighter couplings for branch connections

UNDERDRAIN AIR SCOUR DISTRIBUTOR, HUB-RADIAL TYPE