

17th INTERNATIONAL PUMP USER'S SYMPOSIUM

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USER CASE STUDY

SEAL LIFE FOR UNCONVENTIONAL REFINERY PROCESS PUMP

Innovative Low Cost Pumping Solution Proved to be Reliable

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Abstract

During a refinery upgrade, two pumping applications in a new hydrotreating unit were identified taking suction from the same fractionator accumulator. One application was for a typical high-flow, low-head recycle flowstream while the second application was for a very low-flow, high-head product stream. During engineering and procurement, an innovative solution was needed to lower the capital investment while still meeting the premised reliability requirements.

After investigation of conventional solutions, the decision was made to purchase a pump sized for the reflux flow; but also include an auxiliary (booster) impeller sized for the product conditions. This unique pump design included both impellers on the same shaft within the same pump casing. Flow was routed through external piping from the discharge of the main flow to feed the suction of the booster impeller. The booster impeller was sized to provide the additional head necessary to meet the product stream conditions at the low flow rate. Initial capital cost savings over installing four pumps instead of two was approximately \$240,000. In addition, there were energy savings of \$25,000 per year due to the more efficient pump configuration.

Maximizing equipment reliability was also a premised requirement. After nearly four years of continuous operation, the two dual-service pumps have yet to require maintenance. Both process services operate nowhere near their design conditions. The reflux service runs at about half of the rated point while the product flow runs up to double the projected flow. Even with these significant variations from the original design, the pumps are very reliable.

“Dual Service” is Generic for Split Flow™.

Application Description

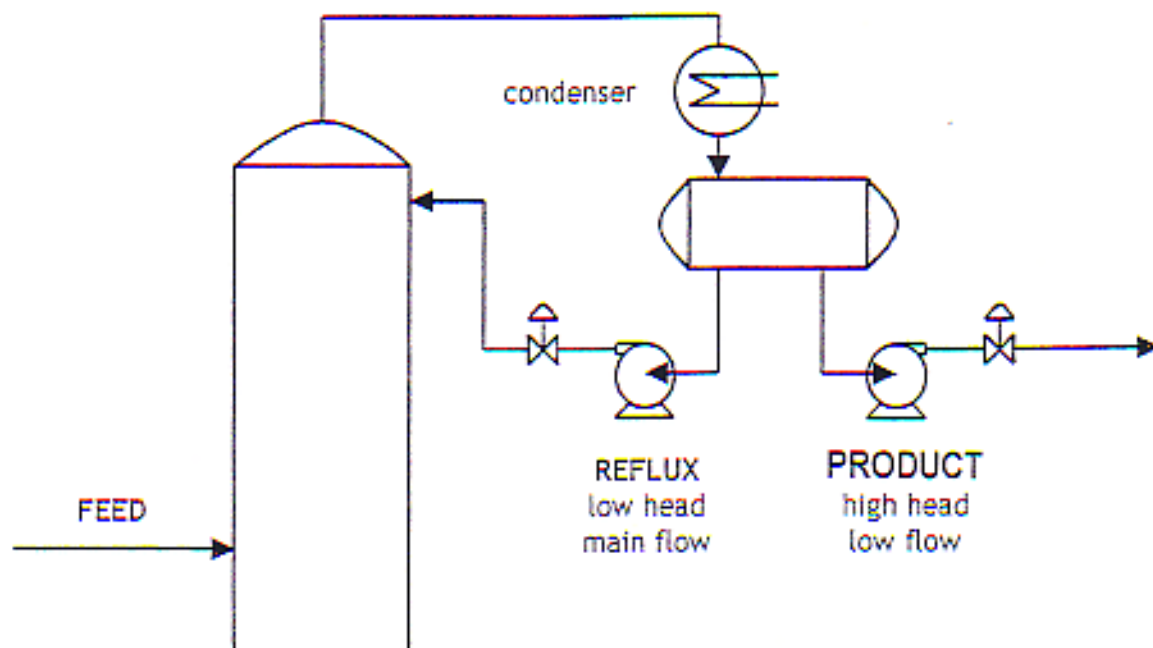
Fractionator Pumps

- Reflux Application
 - Flow = 724 gpm @ Head = 239 ft
 - Suction from Fractionator Accumulator
- Product Application
 - Flow = 7 gpm @ Head = 527 ft
 - Suction from Fractionator Accumulator
- Fractionator Accumulator Process Liquid
 - Temperature = 300°F
 - SG = 0.63 - 0.72

Industry Application Limits

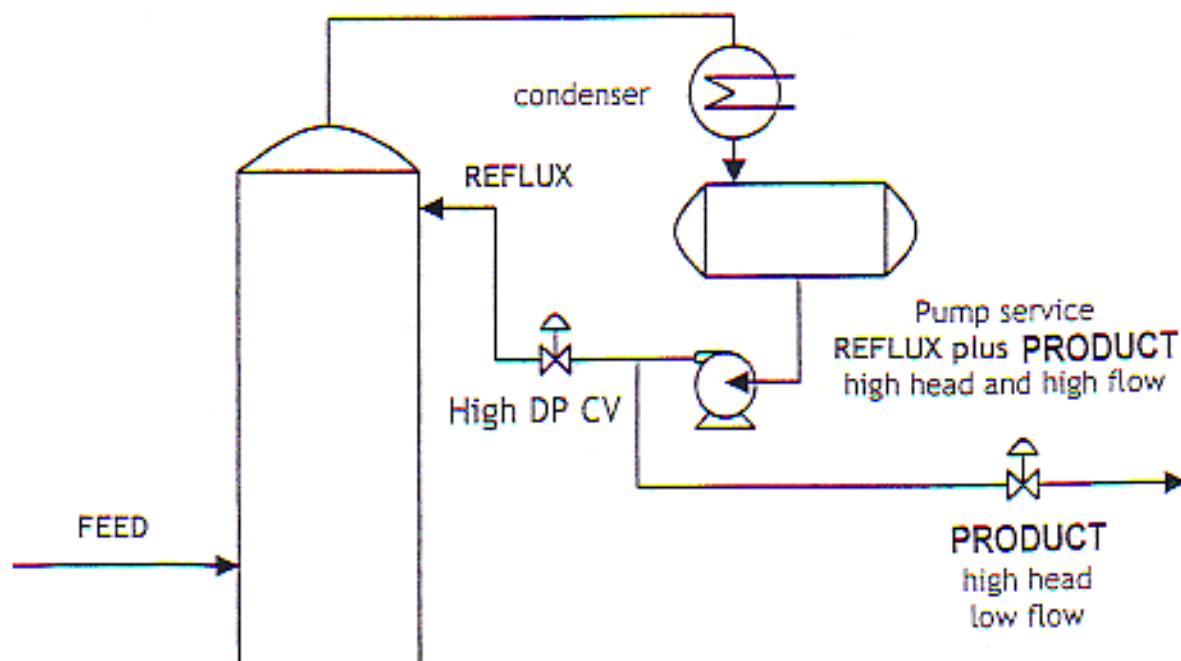
API 610 8th Edition Basic Design Criteria

- Head > 400 ft.
- Temperature > 300°F
- Suction Pressure > 75 psig
- Discharge Press > 275 psig
- Preferred operating range of 70 - 120 % of BEP
- Rated Capacity within 80 - 110 % of BEP



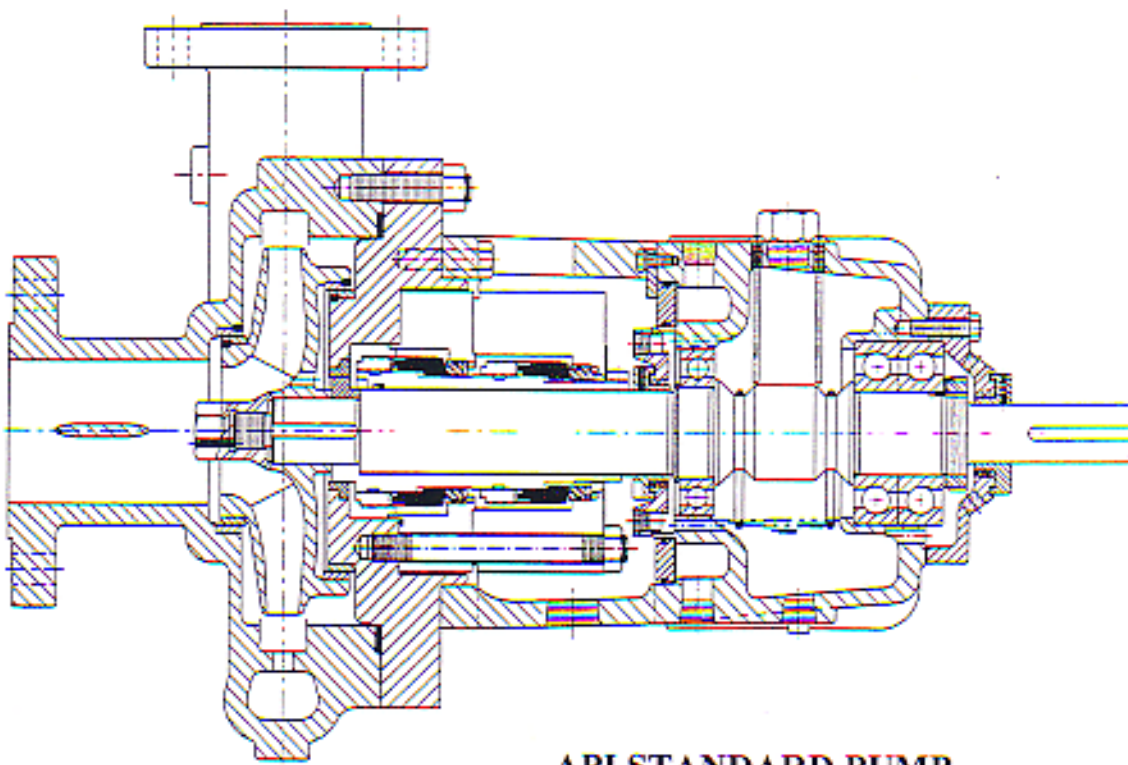
TWO-PUMP SYSTEMS:

Replacing two standard pumps with one dual-service pump reduces capital cost and improves operating efficiency.

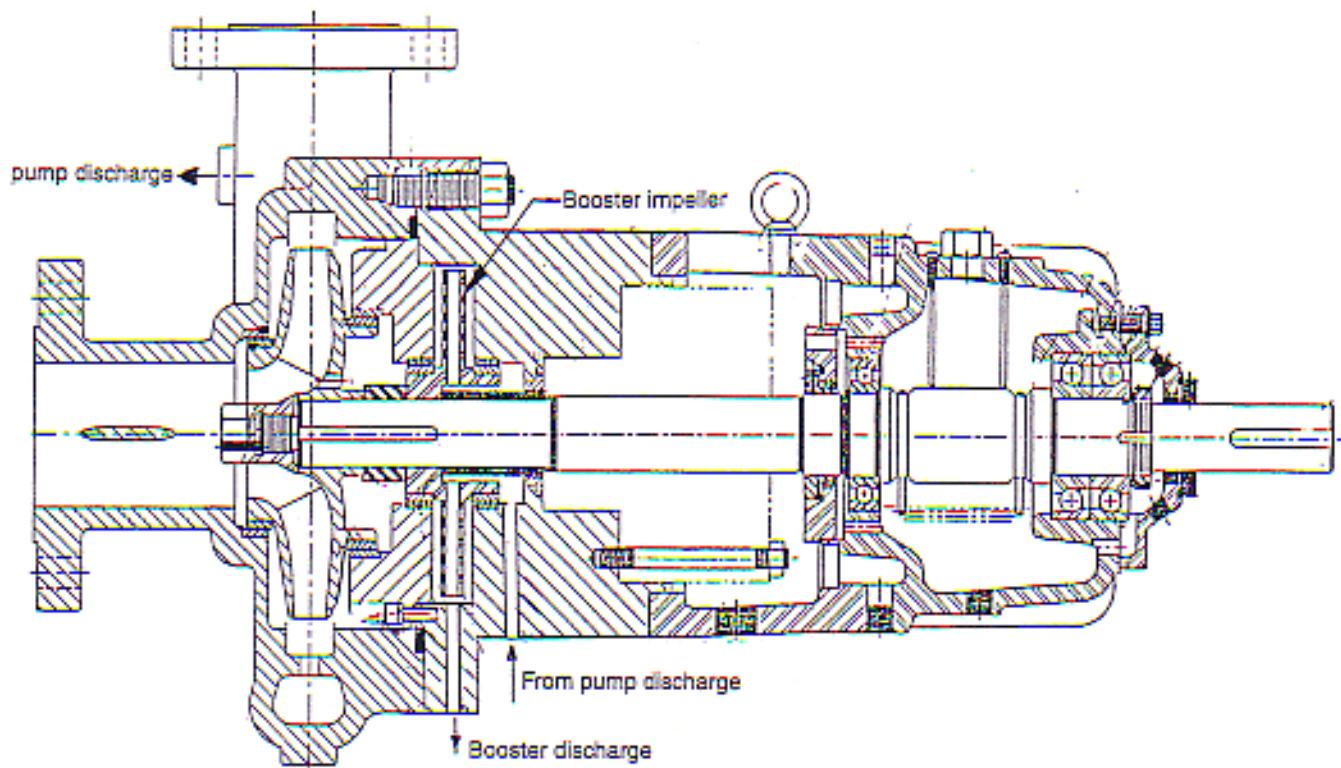


SINGLE-PUMP SYSTEMS (One pump sized for two services):

Use of dual-service pumps improves operating efficiency by not pumping the reflux stream to the higher product head. This allows use of smaller motors.



API STANDARD PUMP

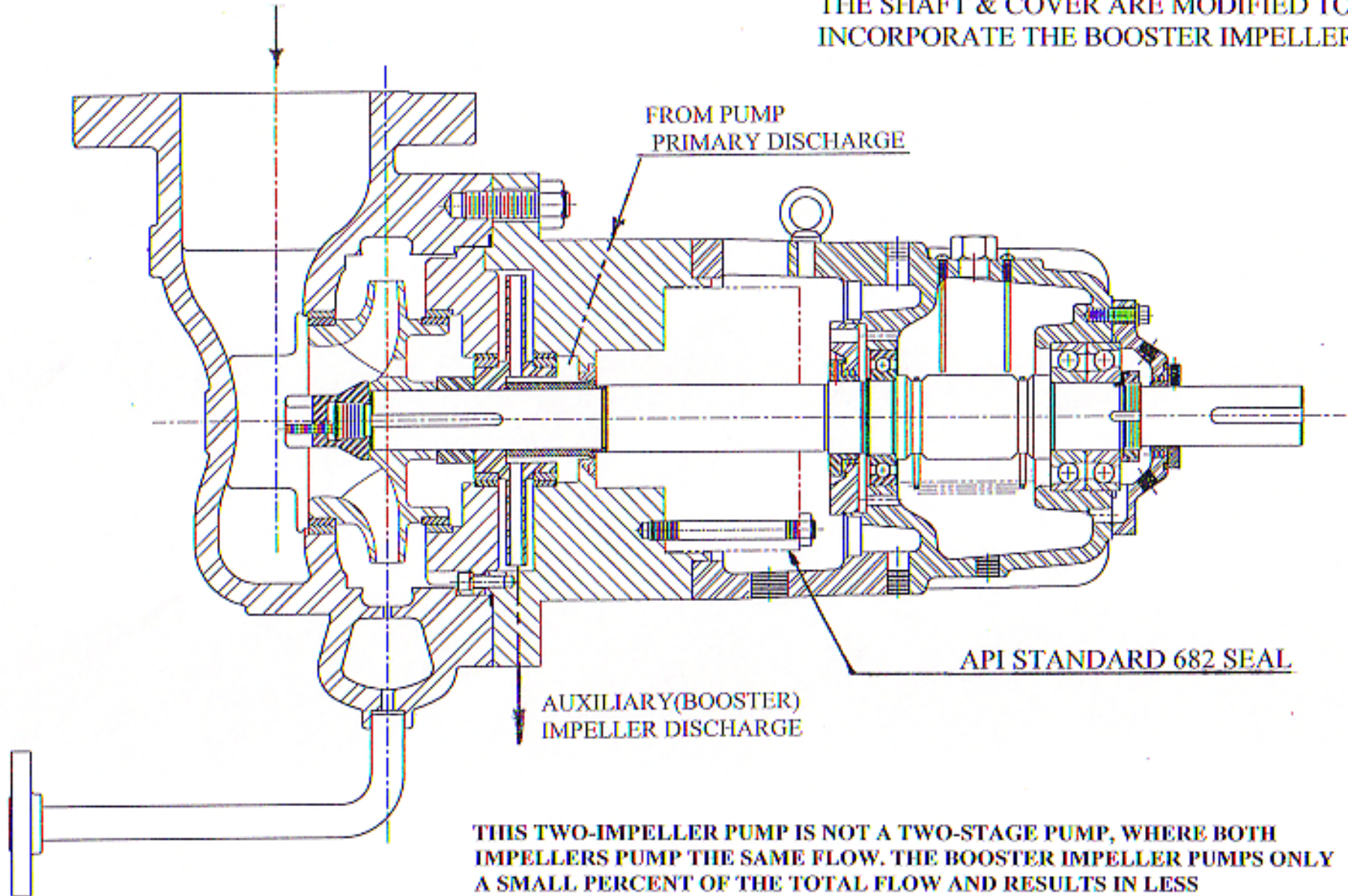


API STANDARD PUMP WITH AUXILIARY (BOOSTER) IMPELLER

A single-stage, overhung centrifugal process pump incorporates a low-flow auxiliary impeller which receives inlet liquid from the discharge of the primary impeller. This feature saves energy by significantly reducing the pump horsepower requirements when the pump is sized for two process conditions, with one discharge flowstream at a higher-head and lower-flow than the other. This enables the pump to separate the inlet flow into a primary high-flow, low-head discharge and a secondary lower-flow, higher-head discharge. The pump is effectively two pumps-in-one with each impeller selected for the discrete process requirements of the different flowstreams. Use of this feature allows the economy of combining two separate pumps into one.

TOP SUCTION
(PRIMARY DISCHARGE IS NOT SHOWN)

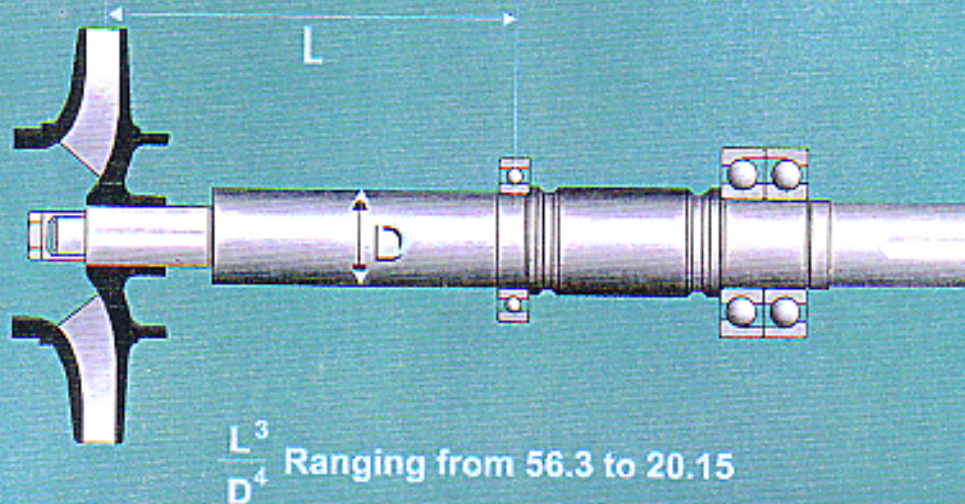
THE PUMP CASE, PRIMARY IMPELLER
AND BEARING BRACKET ARE STANDARD.
THE SHAFT & COVER ARE MODIFIED TO
INCORPORATE THE BOOSTER IMPELLER.



THIS TWO-IMPELLER PUMP IS NOT A TWO-STAGE PUMP, WHERE BOTH IMPELLERS PUMP THE SAME FLOW. THE BOOSTER IMPELLER PUMPS ONLY A SMALL PERCENT OF THE TOTAL FLOW AND RESULTS IN LESS ROTOR/SHAFT OVERHANG/DEFLECTION THAN FOR A CONVENTIONAL TWO-STAGE PUMP.

PROTOTYPE 4 x 6 x 10 BOOSTER/AUXILIARY- IMPELLER PUMP

Heavy Duty Shaft & Bearing System



$\frac{L^3}{D^4}$ Ranging from 56.3 to 20.15

Low $\frac{L^3}{D^4}$ means stiffer rotors and reduced shaft deflections which prolong seal life

Shaft Stiffness and Deflections

Pump Selections	Flow	Head	L^3/D^4	Shaft Deflection
4x6x10	725	240	65	0.0009
4x6x13	725	500	65	0.0012
4x6x10 w/Booster	725	240 / 500	196	0.0016

Shaft deflections (shown in inches) are at the primary seal faces and are based upon the most severe dynamic conditions over the operating range. API Standard 610, paragraph 2.5.7, allows 0.002 inches maximum.