**Mechanical vacuum pump system for steel degassing**

Vacuum Degassing (VD) and Vacuum Oxygen Decarburisation (VOD) are often used in the production of speciality steel alloys. They are used to reduce the levels of hydrogen, carbon and other impurities during the secondary steel making process.

Historically large multi-stage steam ejector systems, backed with liquid ring pumps, have been used. However, these are energy inefficient, rely on high steam quality for consistent performance, and cause foreline dust deposits that develop into “cakes” making cleaning difficult.

Steel degassing in tanks or in the ladle involves two basic processes: Vacuum Degassing (VD) and Vacuum Oxygen Decarburising (VOD). For these processes two types of vacuum pump system have been operated over the past 25 years.

1. The steam ejector system uses multi-stage high pressure steam ejectors usually supported by water sealed Liquid Ring pumps.
2. The alternative mechanical system uses multi-stage mechanical boosters supported by completely dry primary vacuum pumps.

The completely dry pump system has proven to be the most effective. The cost saving is significant, as shown over the page. There are also metallurgical benefits from the elimination of back-streaming of water vapour. Combined with the better ultimate vacuum, this leads to reduced residual hydrogen in the metal. Faster evacuation and more flexible operational characteristics allow for closer chemistry control. This leads to more consistent formulation and opportunities for new steel qualities.

All maintenance costs are reduced, including cost for cleaning the pumps and pipework. The waste disposal costs for the dry dust are also reduced, or the dust can be recycled reducing costs further and limiting the impact on the environment.

**Why mechanical pumps?**

- Cost saving
  - Energy costs reduced by over 90%
- Reduced maintenance
  - Elimination of fore line deposits
- Reduced effluent costs
  - Easier disposal or recycling of dry waste
- Reduced cycle times
  - Vacuum on demand
- Consistent processing
  - Reliable and dependable vacuum level
- Better steel quality
  - Lower hydrogen levels achieved in VD
- Improved stainless quality
  - Better VOD control
- New steel qualities
  - Easier control of chemistry
Operating cost comparison:

Dry mechanical vacuum pumps vs. steam ejectors

Melt mass (tonnes) = 60
Production tonnage = 300,000
Cycle time in vacuum (mins) = 25

Cost criterion | Condition | Specific cost | Steam ejectors | Dry running pumps including filter operating costs
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Consumption
- steam | 12 bar, 194°C | 20.00 €/t | 69.4 kg/t | 1,3888889 €/t |
- contact water | 3 bar, 32°C | 0.04 €/m³ | 4.5 m³/t | 0.1805556 €/t |
- non-contact water | 4 bar, 32°C | 0.03 €/m³ | 528844 €/t |
- compressed air | 5 bar | 0.02 €/m³ | 0.0002500 €/t |
- nitrogen | 5 bar | 0.10 €/m³ | 0.0550000 €/t |
- gear box oil | 3.00 €/liter | 0.0004400 €/t |
- power (pumps+auxiliaries) | 0.05 €/kWh | 0.69 kWh/t | 0.0347222 €/t |
Subtotal consumption | | | 1,6041667 €/t |
Maintenance
- pump service | 35.00 €/pump | 4 | 140.00 €/pump | 5000 tappings | 0.0014000 €/pump |
- pump cleaning | 35.00 €/job | 40 | 1400.00 €/job | 200 tappings | 0.1166667 €/job |
- heat exchanger cleaning | 35.00 €/job | 12 | 420.00 €/job | 5000 tappings | 0.0000003 €/job |
- filter bag changing | 35.00 €/job | 8 | 280.00 €/job | 2083 hours | 0.0000011 €/job |
- dust disposal | 0.00 €/kg | 0.00 kg/t | 0.0000000 €/kg |
- contact water disposal | 1.00 €/m³ | 0.45 m³/t | 0.4513889 €/m³ |
Subtotal maintenance | | | 0.5694556 €/t |
Spares
- filter bags | 15.00 €/change | 216 | 3240.00 €/change | 9 sets/ton | 0.0000033 €/change |
- seals and bearings | 2000.00 €/pump | per installed pump | 3 pumps | 0.0100000 €/pump |
Subtotal spares | | | 2,1836222 €/t |
Difference | | | 0.0000000 €/t |
Annual saving | | | Saving | 636 k€ |

Operating costs

Steam ejectors | Dry running pumps including filter
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Energy and fluids | 1,6041667 €/ton | 0.0282000 €/ton |
Maintenance | 0.5694556 €/ton | 0.0042014 €/ton |
Spares | 0.0100000 €/ton | 0.0300000 €/ton |
TOTAL | 2,1836222 €/ton | 0.0624014 €/ton |
Saving | | | 0% | 97% |