

Diffuser redesign eliminates \$100,000 per year on unplanned maintenance

Chemical plant was making frequent repairs due to a high vibration issue

A chemical processing plant had been experiencing high vibration and bearing failures on their Boiler Feed Water (BFW) Circulation pumps. This application uses a sealless pump, due to the high pressure and high temperature water being circulated. This vibration and wear required that the motors be overhauled approximately once per year at a cost of more than \$100,000. Investigations after initial commissioning of the units indicated that the vibration frequency being measured, 177 Hz, also matched the first bending mode frequency of the rotor; however, the phenomenon which excited this mode was not conclusively identified.

Hayward Tyler engineers were contracted to perform a thorough review of the existing hydraulic design, specifically focused on the impeller and diffuser blade combination. This design used a mixed flow, 6-blade impeller and a radial, 7-blade diffuser. The review identified that the blade pass frequency was also 177Hz and the corresponding radial load was exciting the bending mode of the shaft resulting in excessive damage.

Hayward Tyler engineers evaluated different hydraulic options (impeller blades and diffuser blades) to remove the radial load and settled on a new 8-blade diffuser (original was 7). Computational Fluid Dynamic analysis of the new combination showed a 92% reduction in load at the problematic 177Hz. Furthermore, this new diffuser was designed to fit in the existing footprint meaning only a new diffuser was needed to solve this problem.

The plant ordered new diffusers manufactured by Hayward Tyler, and confirmed upon installation that the 177Hz vibration had been eliminated from the pump. The total cost of the engineering and new diffusers was less than the cost of one motor overhaul.

BASIC DESIGN DETAILS

- Vertical, Motor Under, Glandless Wet Stator Circulating Pump
- Rated Flow: 4270gpm
- Rated Head: 143ft
- Speed: 1780rpm
- Design Pressure: 750psig
- Design Temp: 550° F
- Rated Power: 200hp
- Power Supply: 460V/60 Hz/3ph

Project Summary

SITE / LOCATION:

Chemical/Syngas Plant, USA

SCOPE OF WORK:

- Evaluate source of vibration issue
- Diagnose how to resolve
- Design new hydraulic option
- Evaluate new design using Computational Fluid Dynamics
- Manufacture and install new design on existing pumps
- Support on-site testing of redesigned diffusers
- Verify vibration has been eliminated



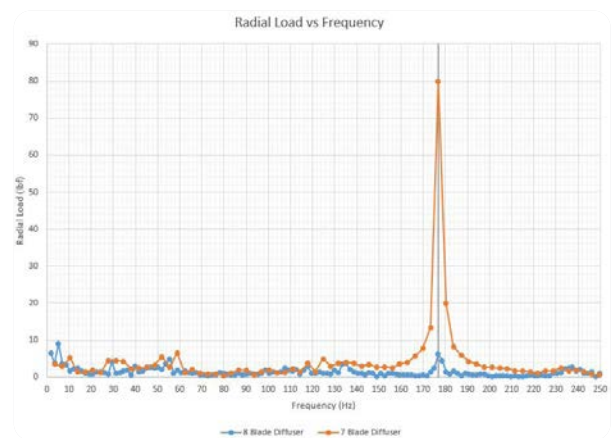
Installed Pump

Project Data Sheet

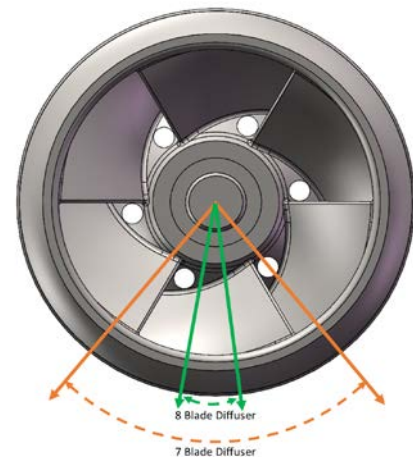
Product	BFW Circulation Pump	
Quantity	Two (2)	
Codes and Standards		
Design Standards	ASME B&PV Sec. VIII Div. I	
Pump Details		
Pump Type	Centrifugal, Single Suction, Single Discharge	
Pump Size	10x12x14 with diffuser	
Fluid Pumped	Boiler Water	
	Imperial	Metric
Rated Flow	4270gpm	970m ³ /hr
Rated Head	143ft	44m
Design Pressure	750psig	52bar
Design Temperature	550° F	288° C
Hydrostatic Test Pressure	1125psig	77bar
NPSHr	30ft	9m
Specific Gravity	0.806	
Original Diffuser	7 blades	
New Diffuser	8 blades	
Motor Details		
Motor Rating	200hp	149kW
Service Factor	1.15	
Nominal Speed	1780	
Power Supply	460V / 3ph / 60Hz	
Motor Full Load Current	289A	
Radial load decrease at 177Hz	92%	
Weights (Approximate Wet)		
	Imperial	Metric
Pump Casing	3,300lbs	1,497kg
Complete Motor and Rotating Assembly	6,000lbs	2,722kg
Heat Exchanger	521lbs	236kg
Total	9,821lbs	4,455kg



8 blade diffuser (top), 7 blade diffuser (bottom)



Radial Load vs Frequency – 8 blade vs 7 blade



Radial load magnitude and changing direction



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