

HIGH ENERGY ABRASIVE SERVICE PUMP UPGRADE

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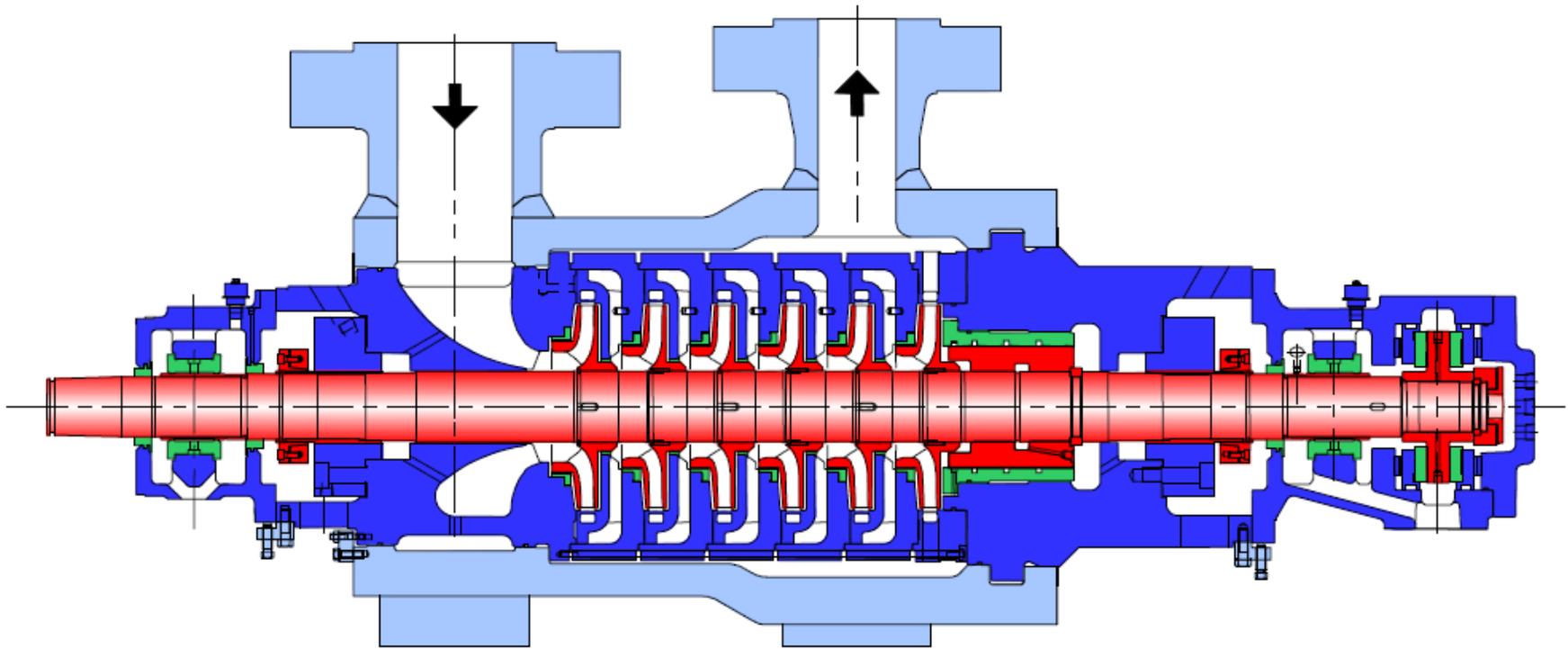
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ABSTRACT

A refining company in the gulf coast had been experiencing accelerated wear on their coke cutting jet pump resulting in major expenditure and down time on a 6-10 month cycle. Application requirements necessitated a pump capable of producing high differential head, while accommodating varied fluid and significant abrasive fines. Frequently pumps are sold and orders are won based on typical quantitative metrics such as efficiency, capital cost and historical design. The following case study shows how minor design changes based on design for longevity can yield cost savings beyond those typically measured on new order contracts.

PROBLEM DESCRIPTION

- 8 STAGE BARREL DIFFUSER (BB5)
- FLOW APPROX 1200gpm (273m³/hr), RUNNING SPEED > 4200RPM, DISCHARGE PRESSURES >4000psig (8274kPag)
- COKE CUTTING SERVICE
- PUMPING DECOKING WATER
- DECOKING WATER IS PRIMARILY COMPOSED OF WASTE WATER FROM OTHER PLANT OPERATIONS. CAN CONTAIN VARYING COMPOSITIONS OF COKE FINES (2500ppm TYPICAL) AND RESIDUAL CORROSIVE MEDIA SUCH AS H₂S
- OPERATION AT LOW FLOW HAS ALSO RESULTED IN SUCTION / DISCHARGE RECIRCULATION DAMAGE
- PUMP MTBF 6-10 MONTHS
- PUMP OVERHAUL TYPICALLY INITIATED BY OBSERVATION OF HIGH THRUST BEARING TEMPERATURE AND ROTOR MOVEMENT FROM LOSS OF THRUST BEARING MATERIAL



TYPICAL PUMP DESIGN

TYPICAL WEAR



SUCTION RECIRCULATION DUE TO LOW FLOW OPERATION



HIGH VELOCITY ABRASION AT DIFFUSER INLET

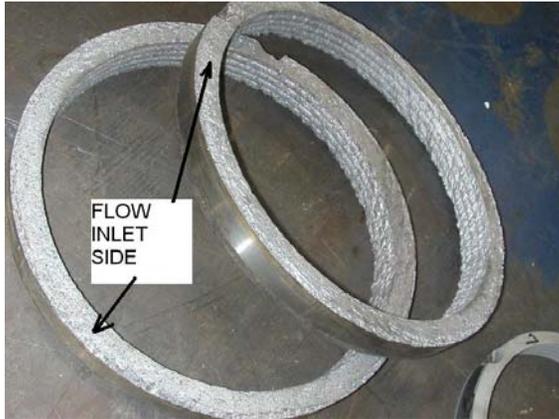


HIGH VELOCITY ABRASION AT DIFFUSER INLET

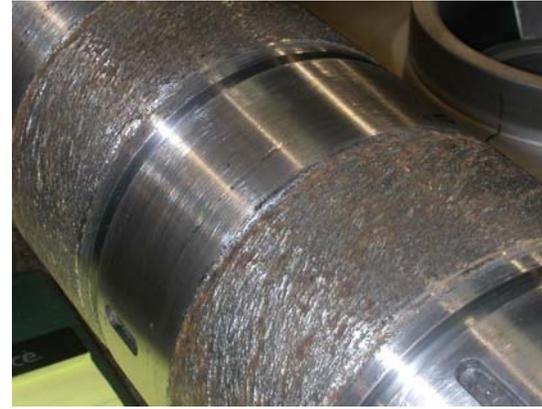


CORROSION EROSION AT SIDE FACES. SIGNIFICANT LOSS OF MATERIAL AT RUNNING SURFACES

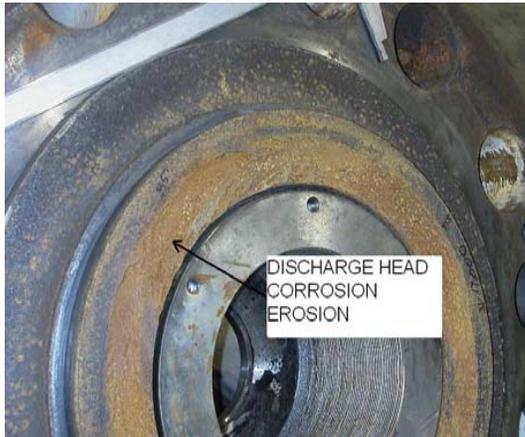
TYPICAL WEAR



CORROSION EROSION AT SIDE FACES.
SIGNIFICANT LOSS OF MATERIAL AT
RUNNING SURFACES



SEVERE EROSION OF SHAFT AT IMPELLER
WATERWAYS



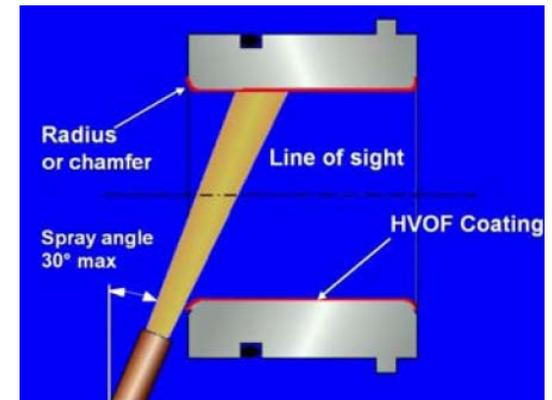
CORROSION EROSION OF CARBON STEEL
DISCHARGE HEAD.



SIGNIFICANT LOSS OF MATERIAL AT
RUNNING SURFACES

COATING TECHNOLOGY

- HIGH VELOCITY OXY FUEL HARD SURFACE COATINGS USED LIBERALLY ON ALL EROSIVE AND ABRASIVE SURFACES.



- TUNGSTEN CARBIDE BASED COATING SELECTED WITH APPROPRIATE METALLIC BINDER BLEND. HIGH HARDNESS FOR ANTI-GALLING AND ABRASION RESISTANCE $>69R_c$
- BINDER SELECTION REQUIRES CAREFUL CONSIDERATION OF CORROSION RESISTANCE AND GALLING RESISTANCE REQUIREMENTS
- IN ORDER TO ACHIEVE HIGH BOND STRENGTH AND MINIMAL POROSITY (LESS THAN 1%) HIGH IMPORTANCE IS PAID TO APPLICATION PROCESS PARAMETERS SUCH AS SPRAY ANGLE, DEPOSITION VELOCITY AND OTHERS⁶

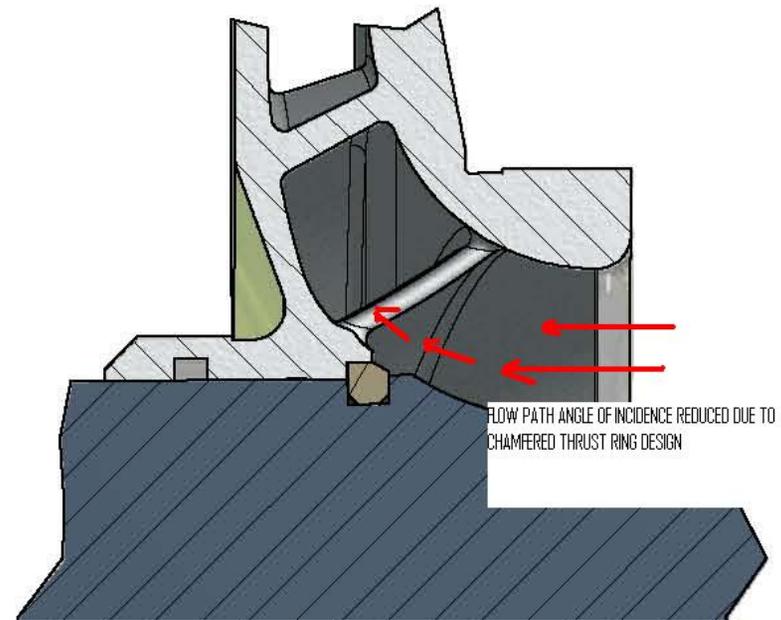
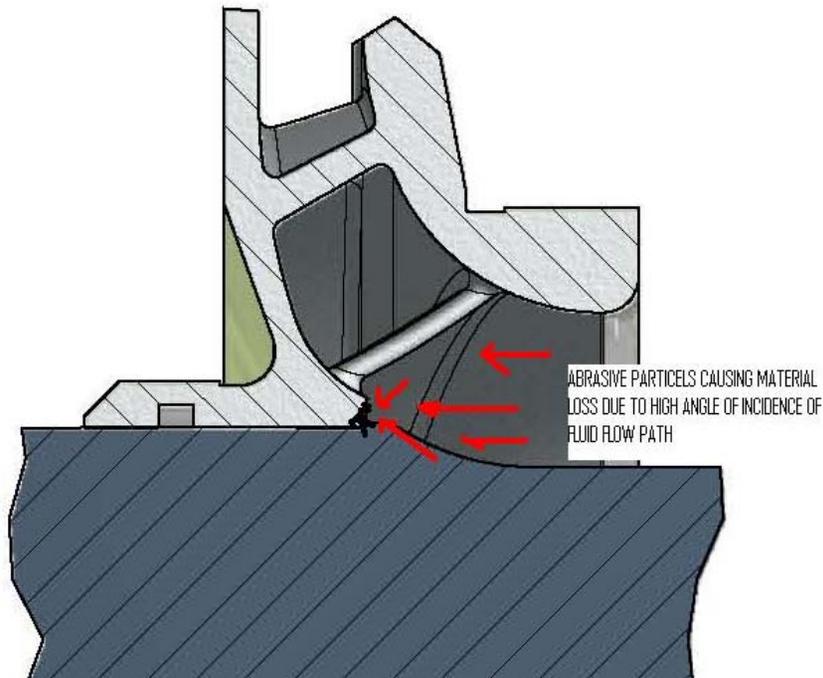
ADDITIONAL MODIFICATIONS

- SUBTLE DESIGN CHANGES IMPLEMENTED TO COMPLIMENT COATING PROCESS
- CORROSION RESISTANT WELDED OVERLAYS APPLIED WHERE NECESSARY
- MINIMUM FLOW POINT RAISED TO REDUCE SUCTION RECIRCULATION CAVITATION DAMAGE AT STAGE 1 IMPELLER. MINIMUM FLOW CONTROLLED BY A 3 WAY CONTROL VALVE. ORIFICE ASSEMBLIES WITHIN THE VALVE WERE MODIFIED TO INCREASE FLOW WHEN IN BYPASS MODE (MINIMUM FLOW).

STAGE 1 SHAFT DAMAGE

STAGE 1 DESIGN CHANGES

- PUMP SHOWED EXCESSIVE DAMAGE AT ABUTMENT SHOULDER OF STAGE 1 IMPELLER. PROFILED THRUST RING ADDED



SHAFT RECLAMATION AND COATING

SHAFT COATING



AS FOUND



COATED. PRIOR TO GRINDING

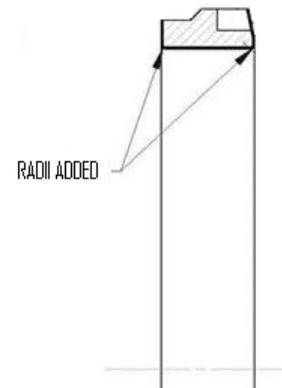


FINISHED SHAFT
GROUND TO SIZE

WEAR PART REDESIGN

WEAR RING MODIFICATIONS

- FINE GROOVES ON WEAR RINGS INCREASE EFFICIENCY BY INDUCING TURBULENCE THAT RESTRICTS BUSH FLOW. THIS TURBULENCE CREATES ADDITIONAL UNWANTED ABRASION
- GROOVES ARE TYPICALLY DESTABILIZING TO PUMP ROTOR



CARTRIDGE RECLAMATION AND COATING

DIFFUSER AND STAGE CASE MODIFICATIONS

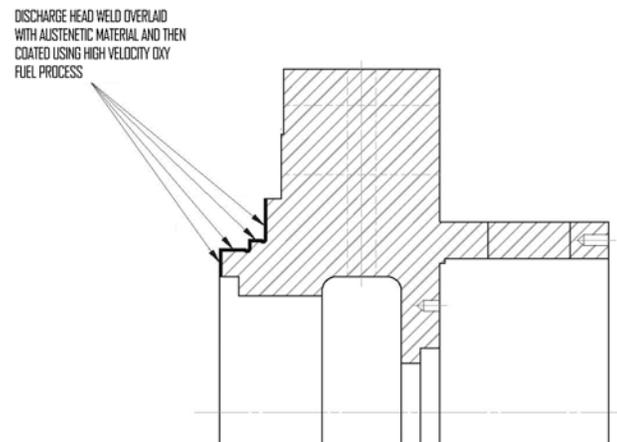
- DIFFUSER AND STAGE CASINGS COATED TO LINE OF SIGHT
- CARE TAKEN TO ENSURE MINIMAL AFFECT ON PUMP HYDRAULICS



CARTRIDGE RECLAMATION AND COATING

DISCHARGE HEAD AND HIGH PRESSURE BUSHING MODIFICATIONS

- HEAD OVERLAID WITH AUSTENITIC MATERIAL AND ADDITIONALLY COATED USING HIGH VELOCITY OXY FUEL PROCESSES
- HIGH PRESSURE BUSHINGS COATED USING HIGH VELOCITY OXY FUEL PROCESS



IN CONCLUSION

- PUMP HAS BEEN IN OPERATION SINCE JAN 2007 AND HAS SHOWN NO SIGNS OF PERFORMANCE DEGRADATION
- IN ADDITION TO CUTTING PRESSURE, PUMP THRUST BEARING TEMPERATURE HAS BEEN USED AS AN INDICATOR OF WEAR. PUMP USUALLY PULLED WHEN BEARINGS GET UP TO 240°F (116°C)
- INCREASED BEARING TEMPERATURE IS CAUSED BY WORN RUNNING CLEARANCES THAT INDUCE A CHANGE IN NET THRUST LOAD. LARGE CLEARANCES RESULT IN MORE LEAKAGE ACROSS THE HIGH PRESSURE BUSHING AND IMPELLER WEAR PARTS. IMPELLER WEAR PART LEAKAGE CHANGES THE SHROUD PRESSURE PROFILE. HIGH PRESSURE BUSHING LEAKAGE INCREASES BACK PRESSURE AT THE BALANCE RETURN LINE CHAMBER. COATED WEAR PARTS PROVIDE IMPROVED WEAR RESISTANCE, MAINTAIN DESIGN CLEARANCES LONGER AND CONSEQUENTLY MAINTAIN DESIGN NET THRUST LOADING
- AFTER MORE THAN 1.5 YEARS OPERATION THE THRUST BEARING TEMPERATURES STILL LOW AT 140°F (60°C)