Compression Service Technology

MAINTENANCE CONSULTANCY SUCCESS STORIES

OFF-SHORE GAS LIFT COMPRESSOR WELDING RUPTURES

APPLICATION	Floating production storage and offloading (FPSO)
COMPRESSOR TYPE	Reciprocating compressor – 3 stg.
SERVICE	Gas lift compressor
NAMEPLATE POWER	1050 kW
DISCH. PRESSURE	120 bara

Examples of inadequate supports for piping and instruments

CHALLENGE:

SUDDEN WELDING RUPTURES ON MINOR BRANCHES

- high vibrations since the first start-up
- skid design failed to consider alternating forces
- poor support design

SOLUTION:

- acoustical study revealed the necessity for:
  - restriction orifices
  - new support installation

CRITICAL VIBRATIONS LOWERED BELOW THE SWRI DANGER VALUE.

NO FAILURES OCCURRED SINCE MODIFICATIONS

HIGH PIPING VIBRATIONS

END USER	HDPE plant
COMPRESSOR TYPE	n°2 Reciprocating compressors – 3 stg.
SERVICE	C_2H_2 feed gas
NAMEPLATE POWER	355 kW
DISCH. PRESSURE	29 bara

CHALLENGE:

UNEXPECTED TRIPS FOR GAS LEAKAGE

- welding ruptures of the inlet nozzle on piping
- acoustic resonance and poor piping clamping

SOLUTION:

- installation of restriction orifices
- stiffening of the existing piping structure
- optimization of clamps disposition

CONTINUOUS RUN AVOIDING UNSCHEDULED TRIPS

EXCESSIVE RIDER BAND WEAR

Cylinder internal, piston and bands

APPLICATION	Paper mill
COMPRESSOR TYPE	Reciprocating compressor – 1 stg.
SERVICE	30 MW Gas turbine fuel supply
NAMEPLATE POWER	500 kW
DISCH. PRESSURE	37 bara

CHALLENGE:

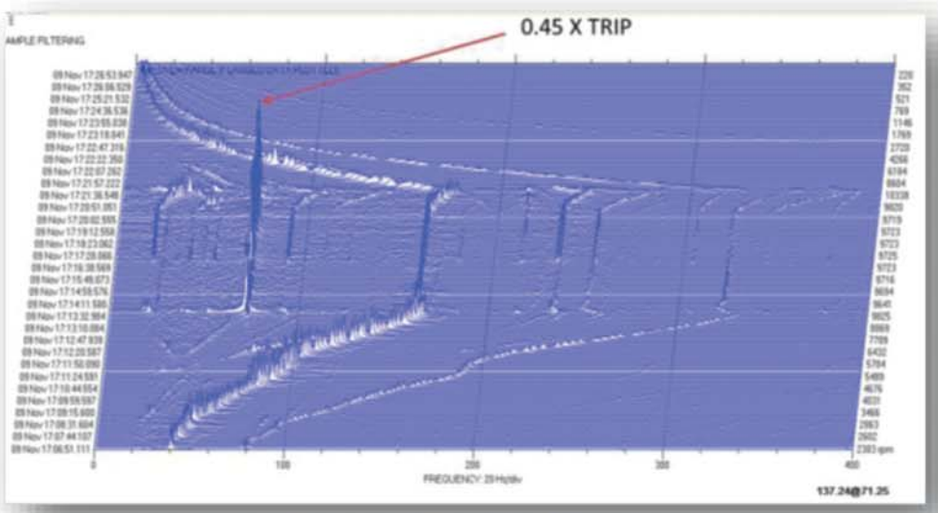
FORCED MAINTENANCE EVERY 3 MONTHS

- rapid wearing of PTFE piston sealing elements

SOLUTION:

- high performance PEEK material suggested
- scheduled temperature monitoring program

COMPRESSOR HAS REACHED 8000 HOURS WITH THE SAME PISTON RINGS, AND IS STILL RUNNING



Bearing Vibration Spectrum

GAS TURBINE START-UP FAILURE

APPLICATION	Natural gas extraction plant
MACHINE TYPE	Two Double-shaft Heavy-duty Gas Turbines
SERVICE	Power generation
NAMEPLATE POWER	5 MW

Old bearing

New bearing

CHALLENGE:

TURBINE COULD NOT START

- high vibrations, both low and high frequency, after maintenance stop

SOLUTION:

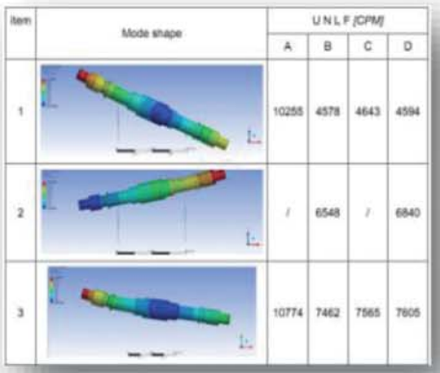
- substitution of some bearings with 4-lobe types (low-frequency vibrations)
- trim balancing (for synchronous vibration)

TURBINE COULD START AND RUN REGULARLY

IGC START-UP FAILURE

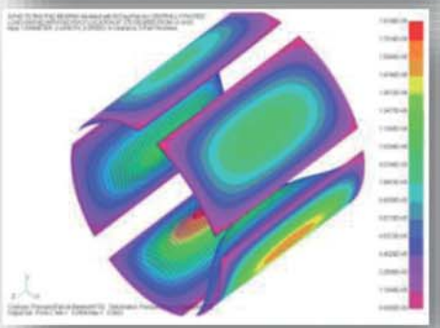
Damaged bearing pad and impeller

APPLICATION	Steel mill
COMPRESSOR TYPE	Integrally geared centrifugal compressor - 3 stg.
SERVICE	Furnace air compressor
NAMEPLATE POWER	4000 kW
DISCH. PRESSURE	50 bara



Item	Mode shape	UNLF [CPM]			
		A	B	C	D
1		10255	4578	4643	4594
2		/	6548	/	6840
3		10774	7462	7565	7805

Bearing load



Lateral analysis

CHALLENGE:

BEARINGS DESTROYED AFTER FIRST START-UP, FOR TWO TIMES

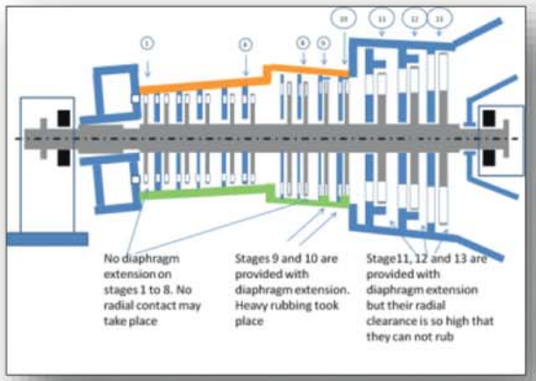
- high vibrations
- major damages to bearings and impeller

SOLUTION:

- increased clearances on new bearings
- check of the rotor design
- check of the new bearing arrangement

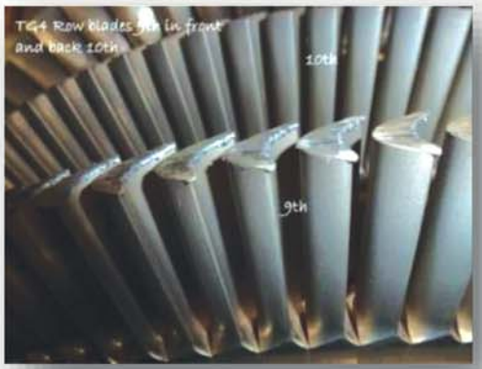
COMPRESSOR STARTED AND STILL WORKING REGULARLY

STEAM TURBINE FAILURE



Sketch of casing bow

END USER	Floating Storage & Regasification Unit (FSRU)
MACHINE TYPE	Steam Turbine
SERVICE	Power generation
NAMEPLATE POWER	10 MW



Rubbing of blades

CHALLENGE:

TURBINE TRIP DURING COMMISSIONING START-UP

- severe damages to the rotors
- casing bow (non uniform expansion), resulting from an insufficient thermal insulation of the casing

Bottom half cylinder insulation blanket thickness

SOLUTION:

- re-calculation of the thickness of the thermal insulation
- suggested correct procedure for turbine warm-up
- revised seals radial clearance

TURBINE STARTED AND STILL WORKING REGULARLY

EXCESSIVE PACKING SEAL WEAR

Ruined packing rings

Rod wearing

APPLICATION	Refinery
COMPRESSOR TYPE	Reciprocating compressor – 2 stg.
SERVICE	Penex process compressor
NAMEPLATE POWER	90 kW
DISCH. PRESSURE	80 bara

CHALLENGE:

ROD PACKING ELEMENTS LIFE WAS <1000 HOURS

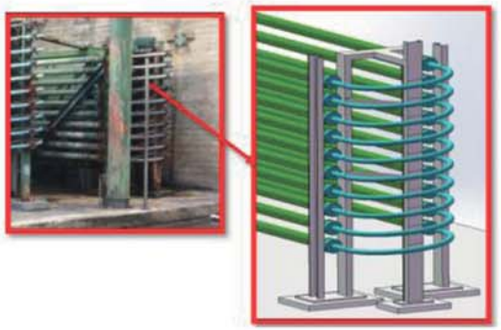
- recurrent rod scratching
- chromium on the rod surface

SOLUTION:

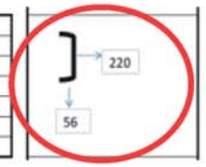
- roughening treatment to increase the transfer film capacity
- suggested high performance PEEK material

ROD PACKING ELEMENTS LIFE WAS BROUGHT TO ~8000 HOURS

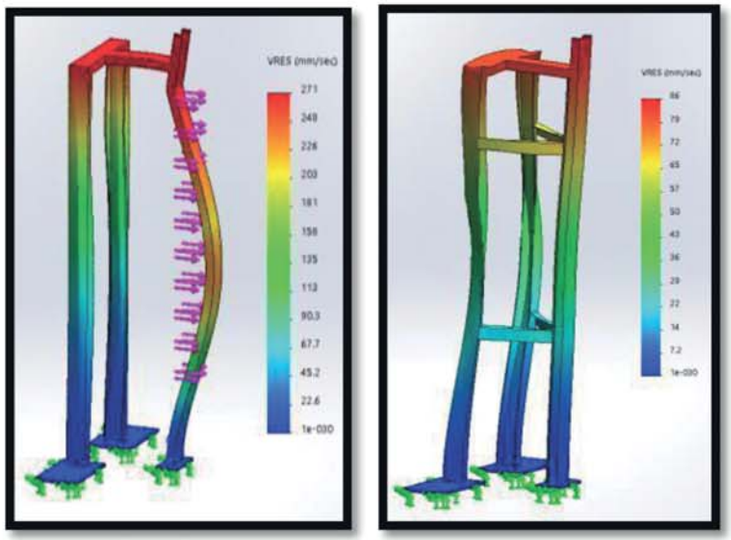
VIBRATIONS OF AN LDPE HIGH PRESSURE COOLER



E303 B	INGRESSO	26	13.5	25
	META'	255	200	15
	USCITA	40	24	26
	TUBI LATERALI (Basso/Alto)	170/16		150/22
	BASAMENTO LATO COMPRESSORE	1.5	1.1	6.0
	BASAMENTO META'	4.5	1.2	5.0
	BASAMENTO LATO OPPOSTO	1.0	<1	4.8



Cooler vibration



FEM analysis made to optimize cooler structure reinforcement

APPLICATION	Low Density Polyethylene Plant
COMPRESSOR TYPE	Reciprocating compressor – 2 stg.
SERVICE	LDPE process secondary compressor
NAMEPLATE POWER	5800 kW
DISCH. PRESSURE	3200 bara

CHALLENGE:

RUPTURES ON PIPES AND SUPPORTS (EVERY 2-3 MONTHS)

- high vibrations (up to 250 mm/s rms)
- supporting structure inadequacy
- any modification had to be performed in just one week

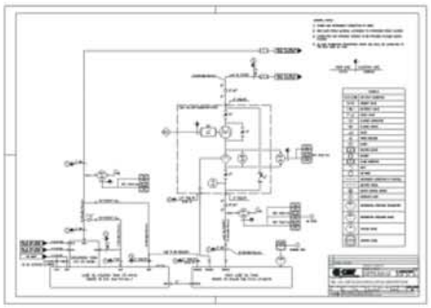
SOLUTION:

- optimized modifications verified with FEM
- foundations reinforced through grouting
- follow-up survey to confirm root cause analysis and resolution

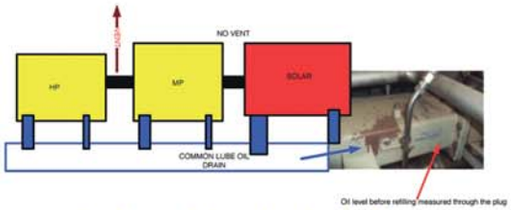
ALL VIBRATIONS LOWERED BELOW SWRI DANGER VALUE.

NO FAILURES OCCURRED SINCE MODIFICATIONS

GAS TURBINE CABINET EXPLOSION



Modified P&I



Lube oil tank sketch

APPLICATION	Gas extraction plant
MACHINE TYPE	Heavy-duty Gas Turbine
SERVICE	Centrifugal compressor drive
NAMEPLATE POWER	10 MW

Turbine Cabinet

CHALLENGE:

EXPLOSION IN THE TURBINE CABINET

- failure of oil trap level control loop
- vent line clogged

SOLUTION:

- lube oil tank fill-up procedure
- lube oil vent system modified

EVENT DID NOT OCCUR ANYMORE

STIRRER BEARING RUPTURE

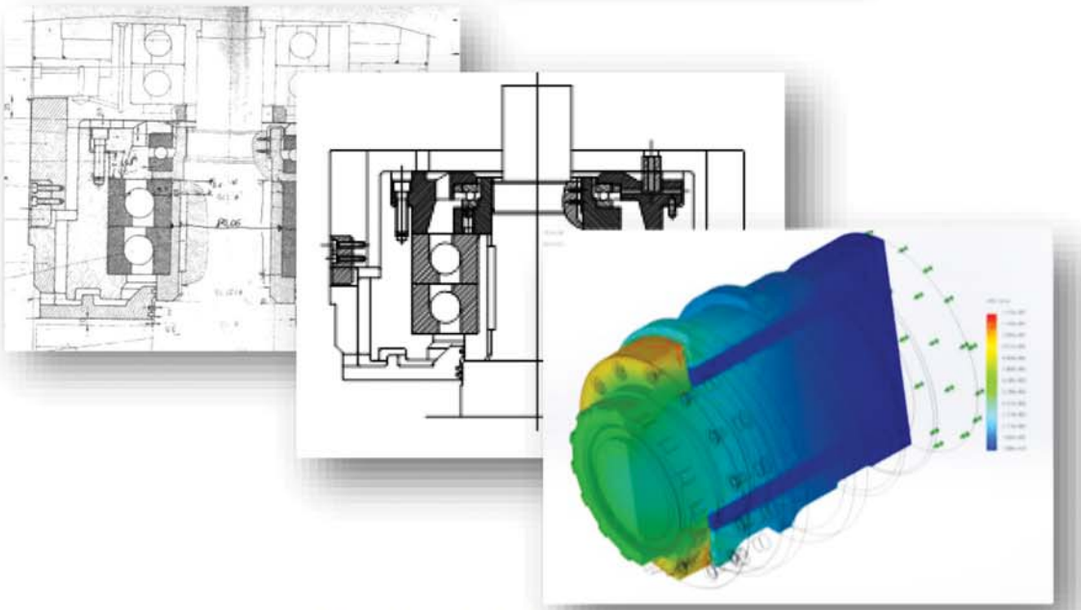
APPLICATION	Low Density Polyethylene Plant
MACHINE TYPE	Stirrer of an autoclave reactor

Bearing failures

CHALLENGE:

BEARING HAD TO BE SUBSTITUTED EVERY 3 MONTHS

- reported also one catastrophic rupture



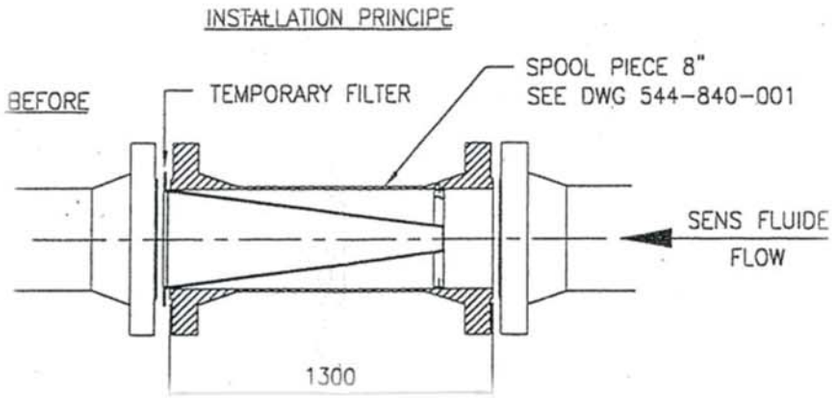
New bush design

SOLUTION:

- new bush design
- superbolt style tightening method
- detailed tightening procedure

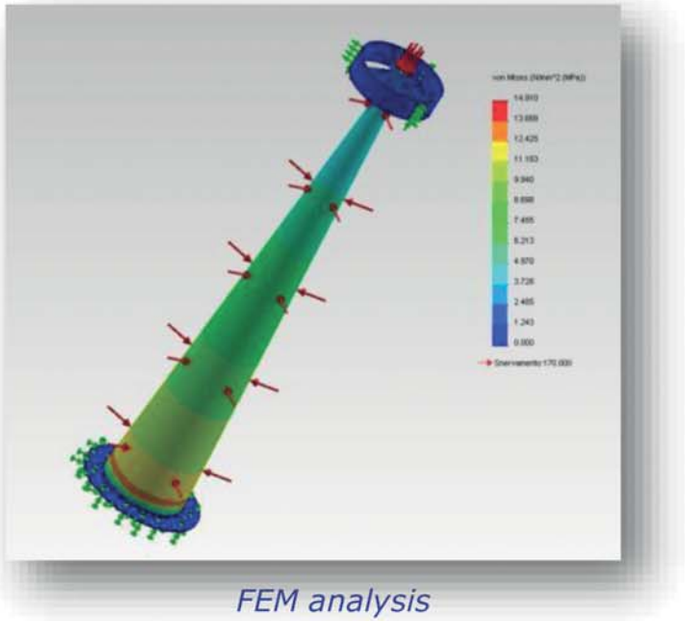
TWO INSPECTIONS IN THE LAST YEAR REVEALED THAT BEARING WAS STILL FINE

TEMPORARY STRAINER CLOGGING



Temporary strainer schematic

APPLICATION	Refinery
COMPRESSOR TYPE	Centrifugal compressor
SERVICE	Mild Hydrocracking make-up compress
NAMEPLATE POWER	900 kW
DISCH. PRESSURE	90 bara



FEM analysis results

CHALLENGE:

ΔP ON A TEMPORARY STRAINER QUICKLY ROSE TO ~1.3 BAR

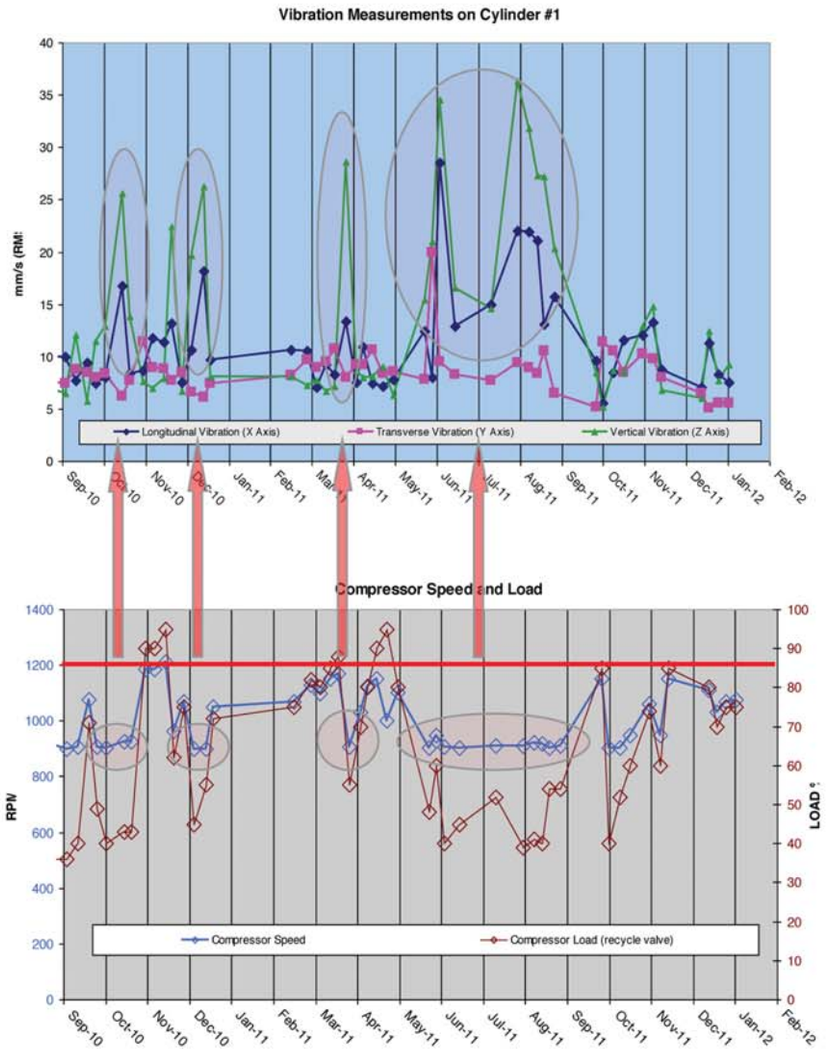
- customer could not stop production before scheduled maintenance

SOLUTION:

- finite element analysis and a buckling analysis
- maximum sustainable pressure drop ~ 4 bar

CUSTOMER STOPPED AFTER ONE YEAR AS SCHEDULED

RECIP. COMPRESSOR HIGH VIBRATION
(DIAGNOSTIC)



Correlation between rotation speed and vibration

APPLICATION	Gas extraction plant
COMPRESSOR TYPE	Reciprocating compressor – 1 stg.
SERVICE	Gas compression LP
NAMEPLATE POWER	700 kW
DISCH. PRESSURE	30 bara

CHALLENGE:

PERIODICAL HIGH VIBRATION

- correlation between rotation speed and high vibration
- mechanical resonant frequencies

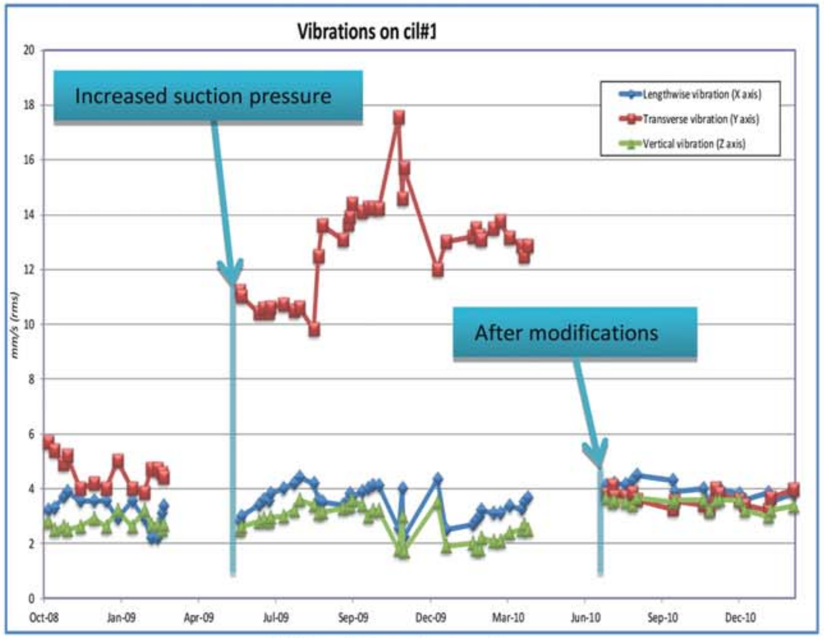
SOLUTION:

- keep rotation speed over a minimum level

AVOIDED POSSIBLE FAILURES CAUSED BY HIGH VIBRATIONS

RECIP. COMPRESSOR HIGH LOAD
(DIAGNOSTIC)

APPLICATION	Petrochemical plant
COMPRESSOR TYPE	Reciprocating compressor – 2 stg.
SERVICE	HC Polymerization
NAMEPLATE POWER	1800 kW
DISCH. PRESSURE	40 bara



Vibration trends

Cylinders

CHALLENGE:

TWO CYLINDER-DISTANCE PIECE TIE-RODS FOUND BROKEN

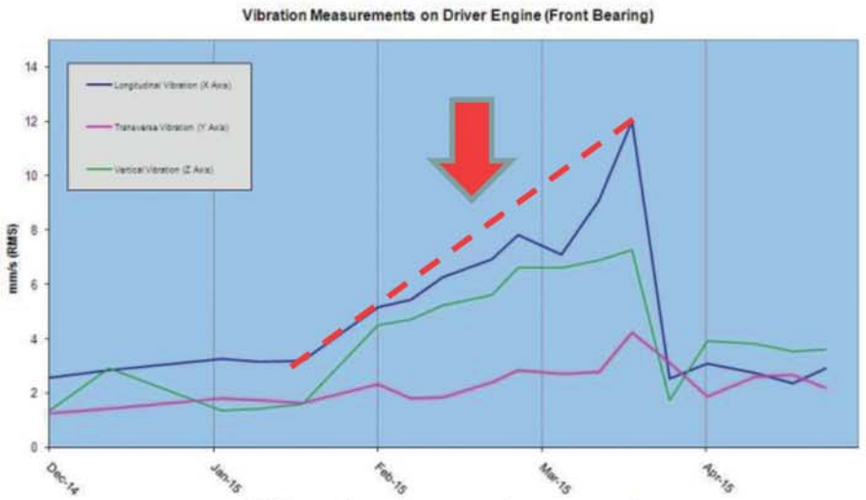
- high cylinder vibrations
- high pin load caused by higher suction pressure

SOLUTION:

- 2nd stage cylinder bore diameter modified
- high-resistance rolled thread tie-rods
- volume bottles size increased

VIBRATIONS AND PIN LOAD RETURNED TO THE ALLOWABLE VALUES

RECIP. COMPRESSOR COUPLING FAILURE
(DIAGNOSTIC)



Vibration increasing trend

APPLICATION	Gas extraction plant
COMPRESSOR TYPE	Reciprocating compressor – 3 stg.
SERVICE	Gas reinjection
NAMEPLATE POWER	1600 kW
DISCH. PRESSURE	150 bara

Damaged coupling

CHALLENGE:

INCREASING DRIVER FRONT BEARING VIBRATION

- found damaged coupling

SOLUTION:

- coupling substitution

AVOIDED UNSCHEDULED STOP AND POSSIBLE CATASTROPHIC FAILURES

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