“Unconventional Artificial Lift Configurations and Deployment Methods”

SPE Applied Technology Workshop

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High GOR Environment
Gas Handling Solutions

NOVOMET®

Aslan Mollaev

SPE International

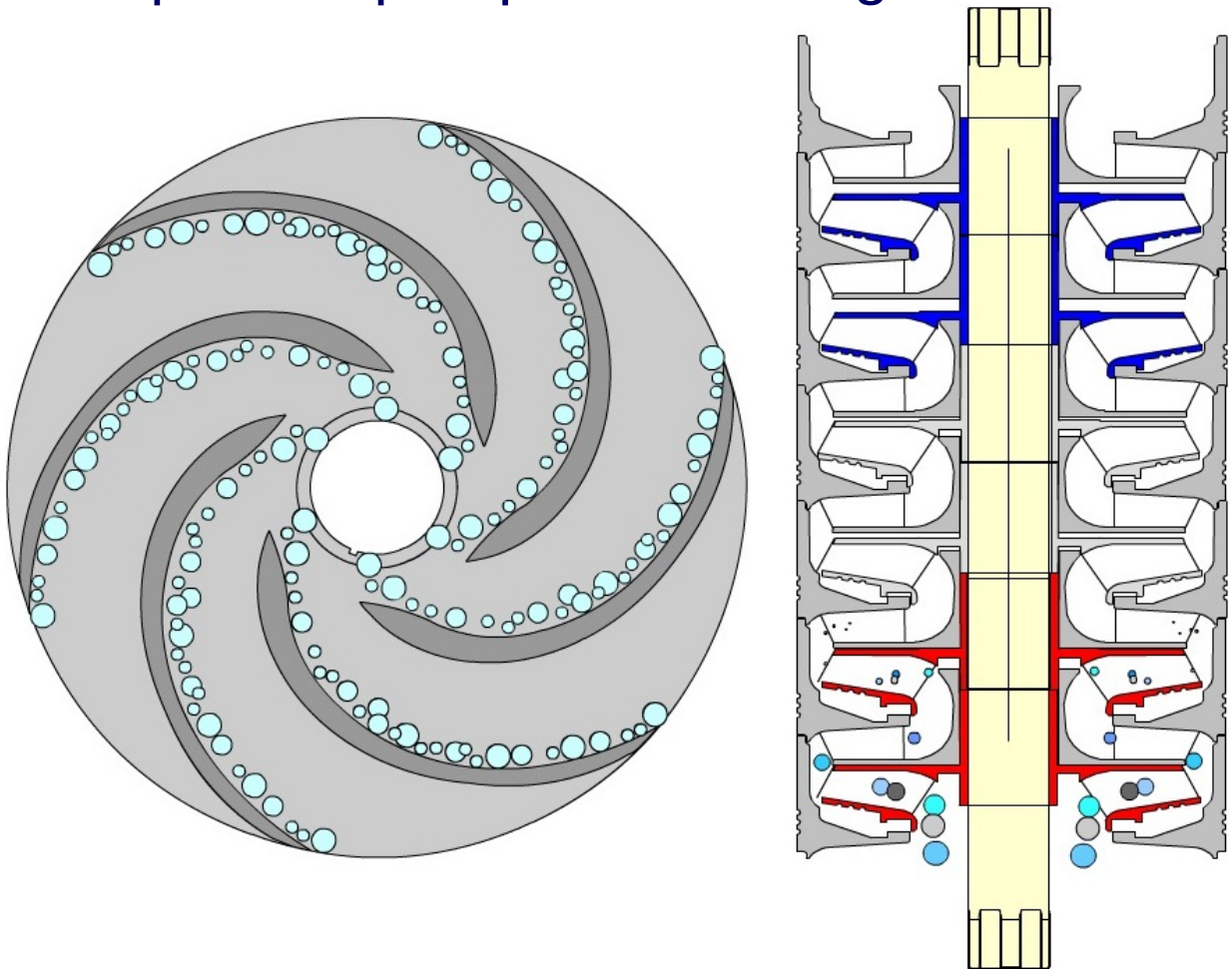
Overview

- Why is High GOR a Problem
- How to Recognize the Gas Influence
- Solutions Available
- Gas Separators
- Abrasion Problems
- Multiphase Pump

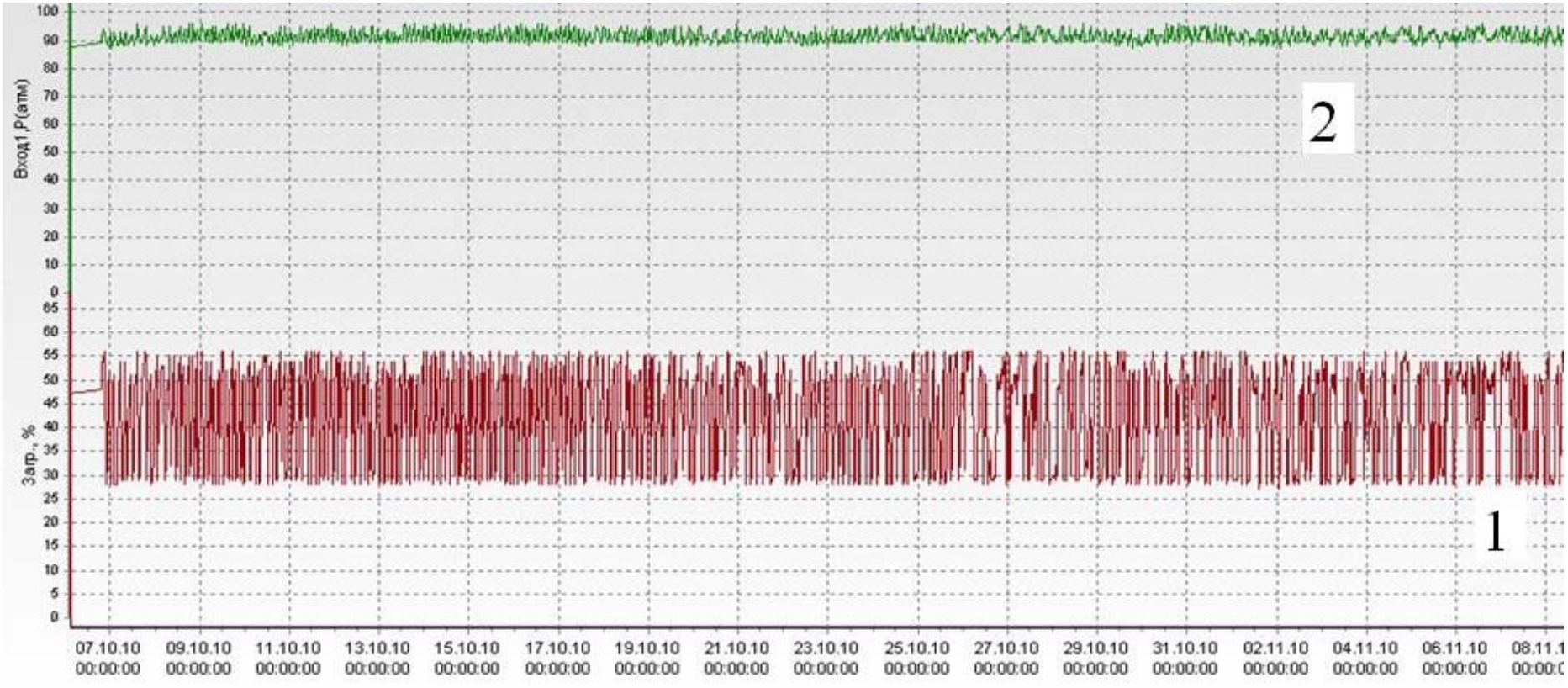
- **Gas tends to "Gas Lock" a pump**
- **Gas does not allow to properly lubricate bearings**
- **Pumping efficiency is reduced**
- **Overall System efficiency will be reduced**

Gas Impact

- Pump efficient capacity is reduced when Gas occupies part of a space in pump's lower stages



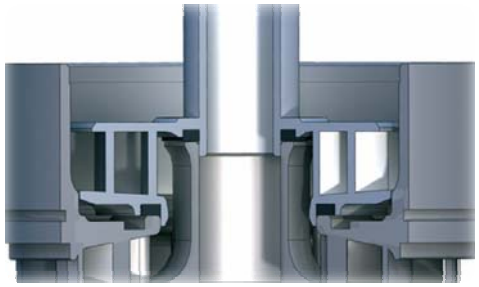
Recognizing a “Gas Problem”



1 – motor load, 27-55%

2 – bottom hole pressure, 1300psi (90atm)

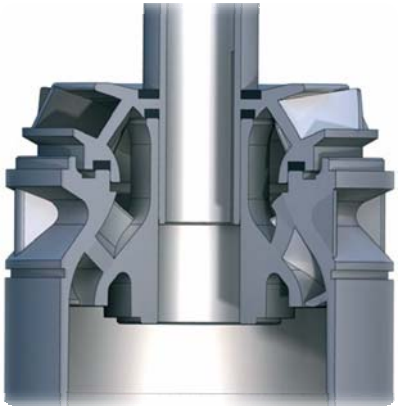
Stage Designs



10 to 15%
free gas by volume

Pancake Stages

Vortex Type 20%



15 to 25%
free gas by volume

Mixed Flow Stages

Vortex Type 30%

Managing a Gas

SOLUTIONS AVAILABLE:

GAS SEPARATION

- **Rotary or Vortex Gas Separator**

GAS HANDLING

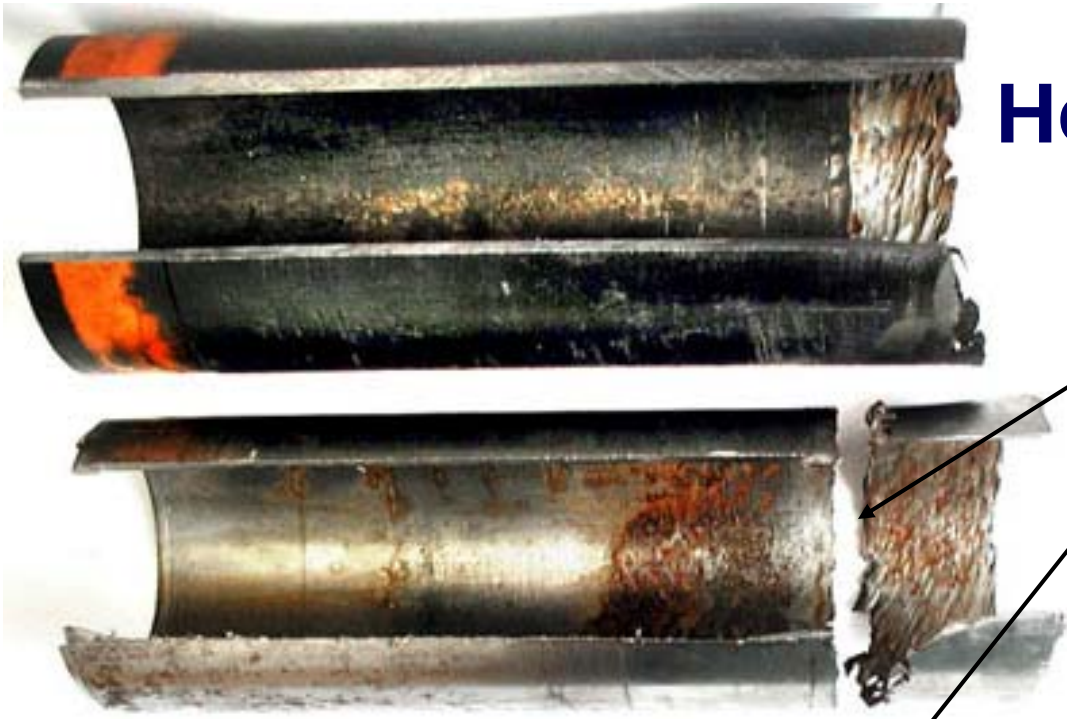
- **Multiphase Pump**

Gas Separators

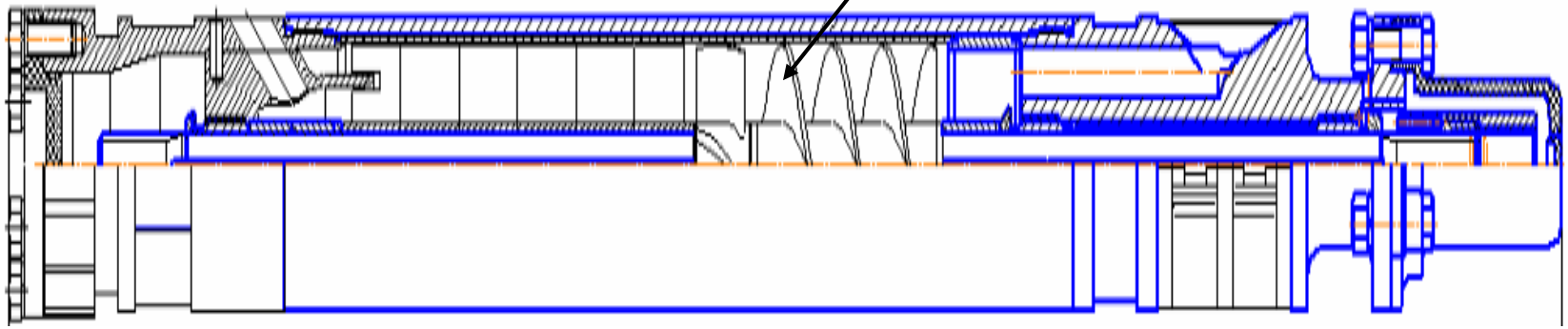
Challenges/limitations:

1. Severe abrasive down-hole conditions(bearings failure) → **AR Bearings – Tungsten and Silicon Carbide**
2. Extremely gassy wells
3. Oil production with non-vented packers
4. Horizontal wells

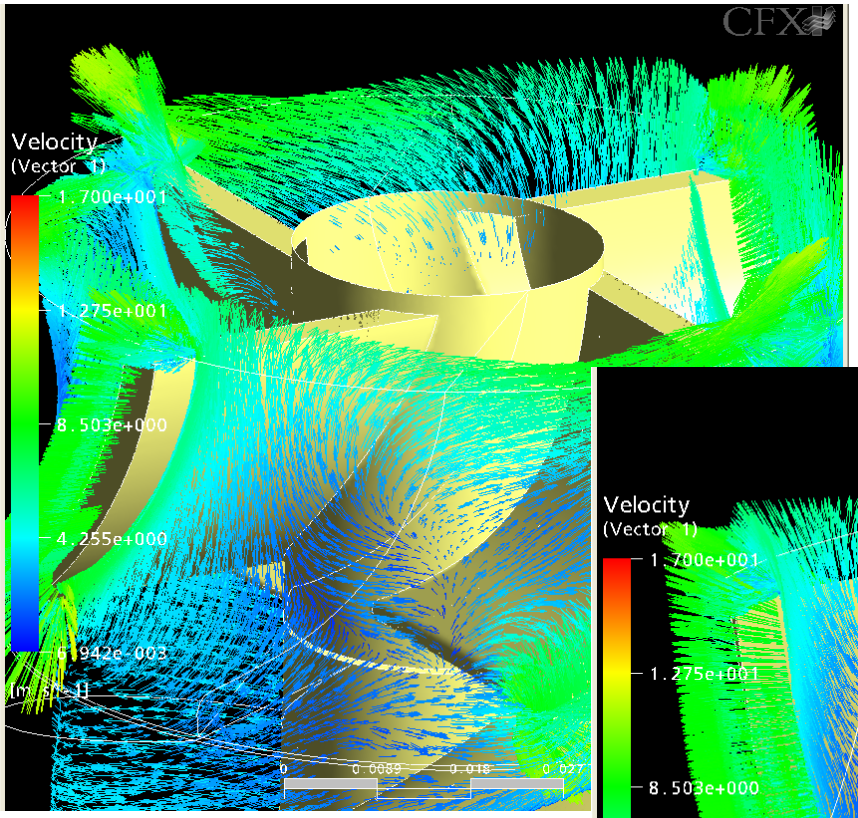
Gas Separators

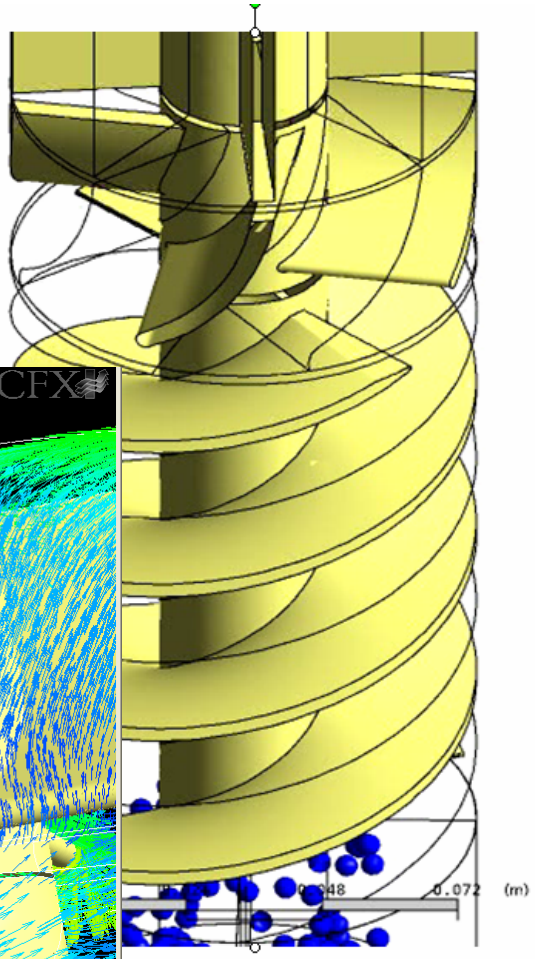


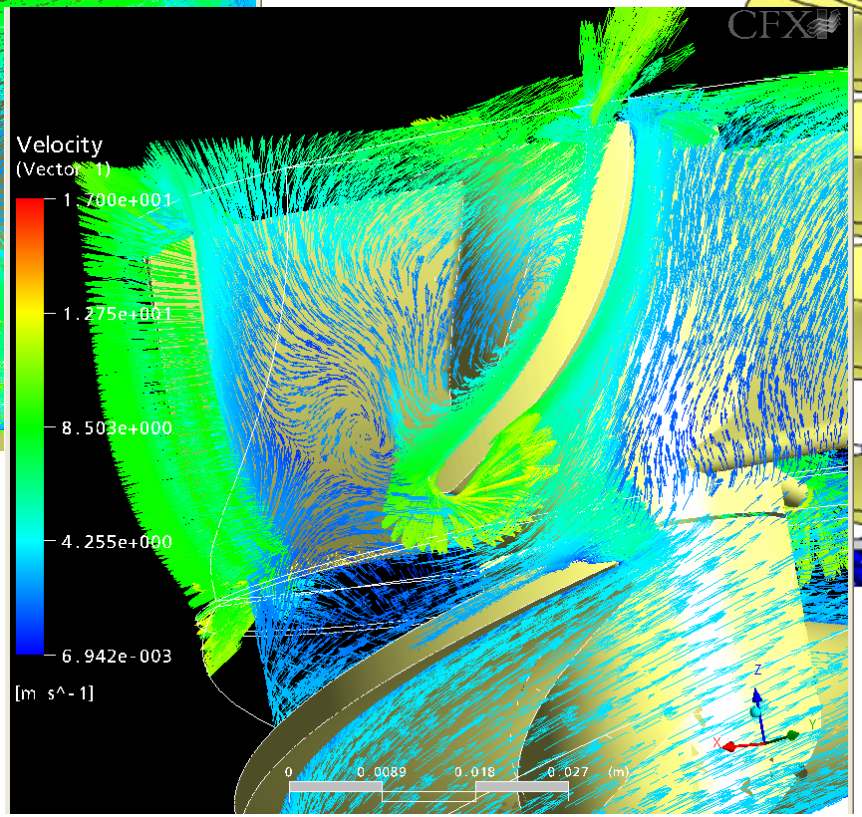
Housing Cutting



Problem Investigation







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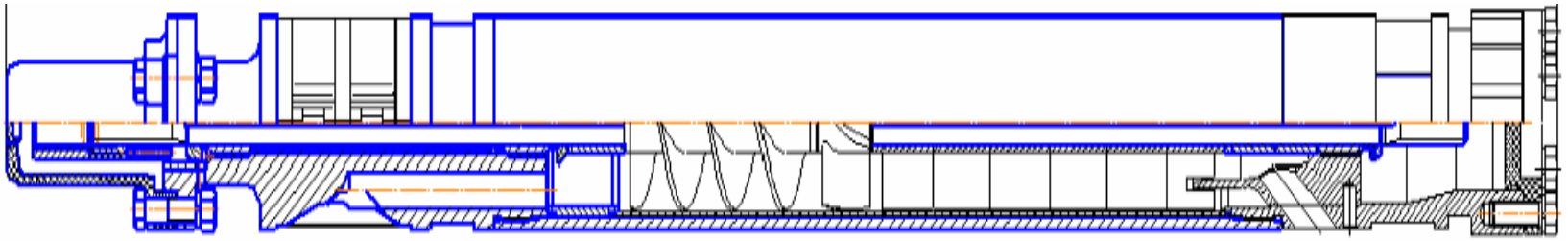

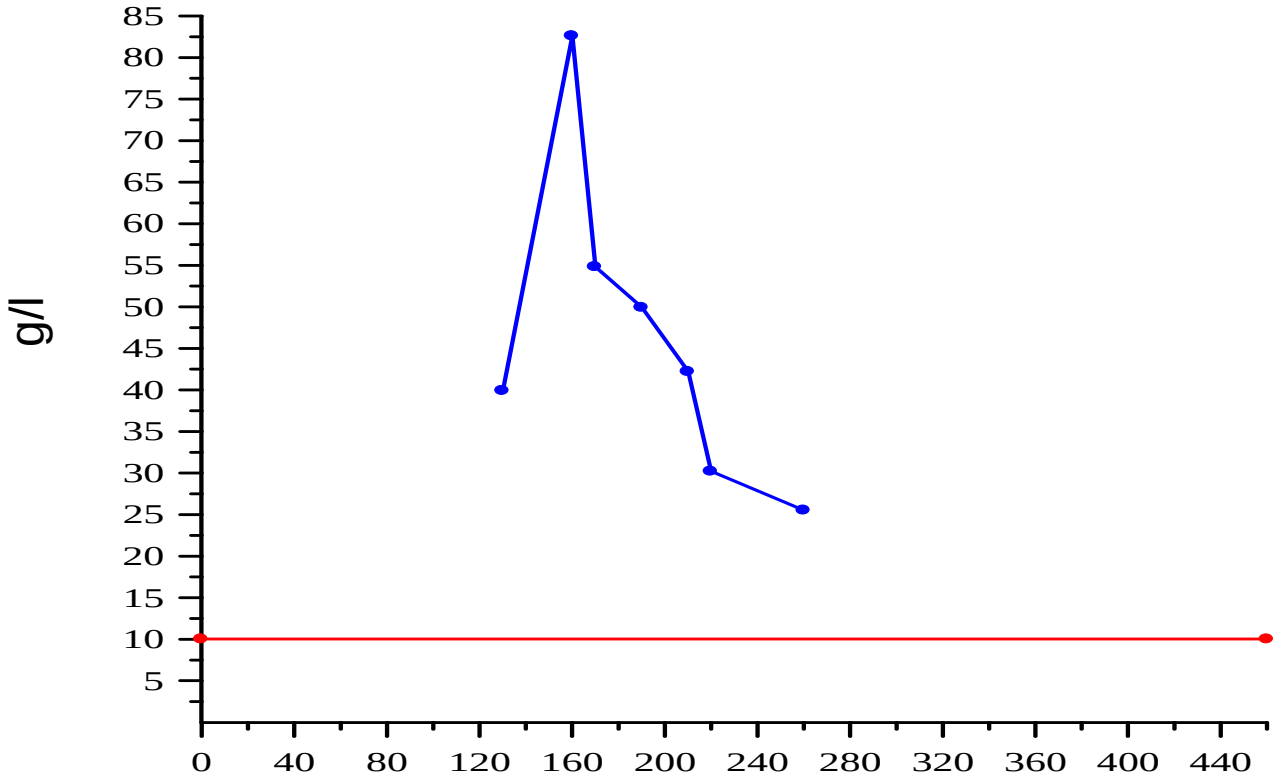

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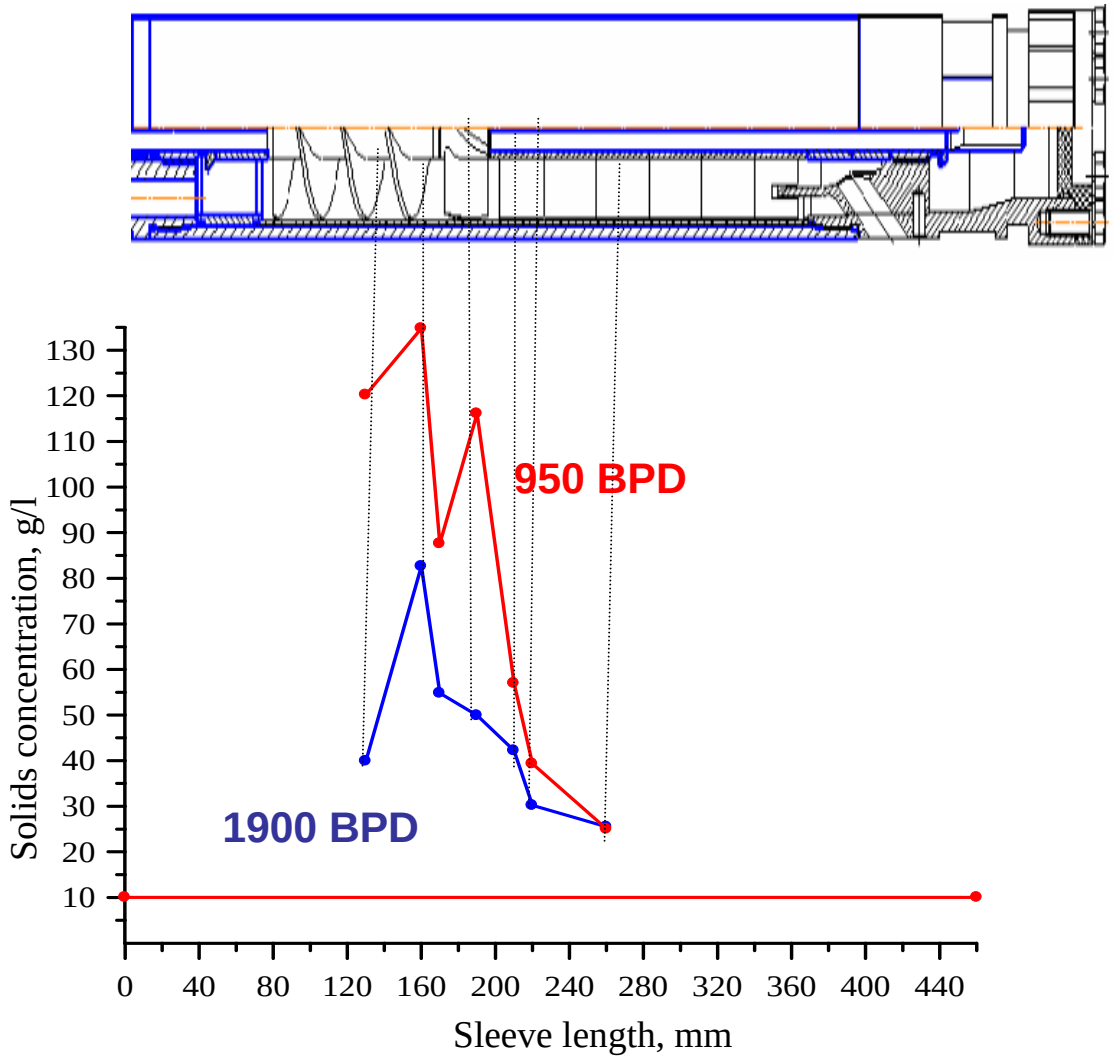
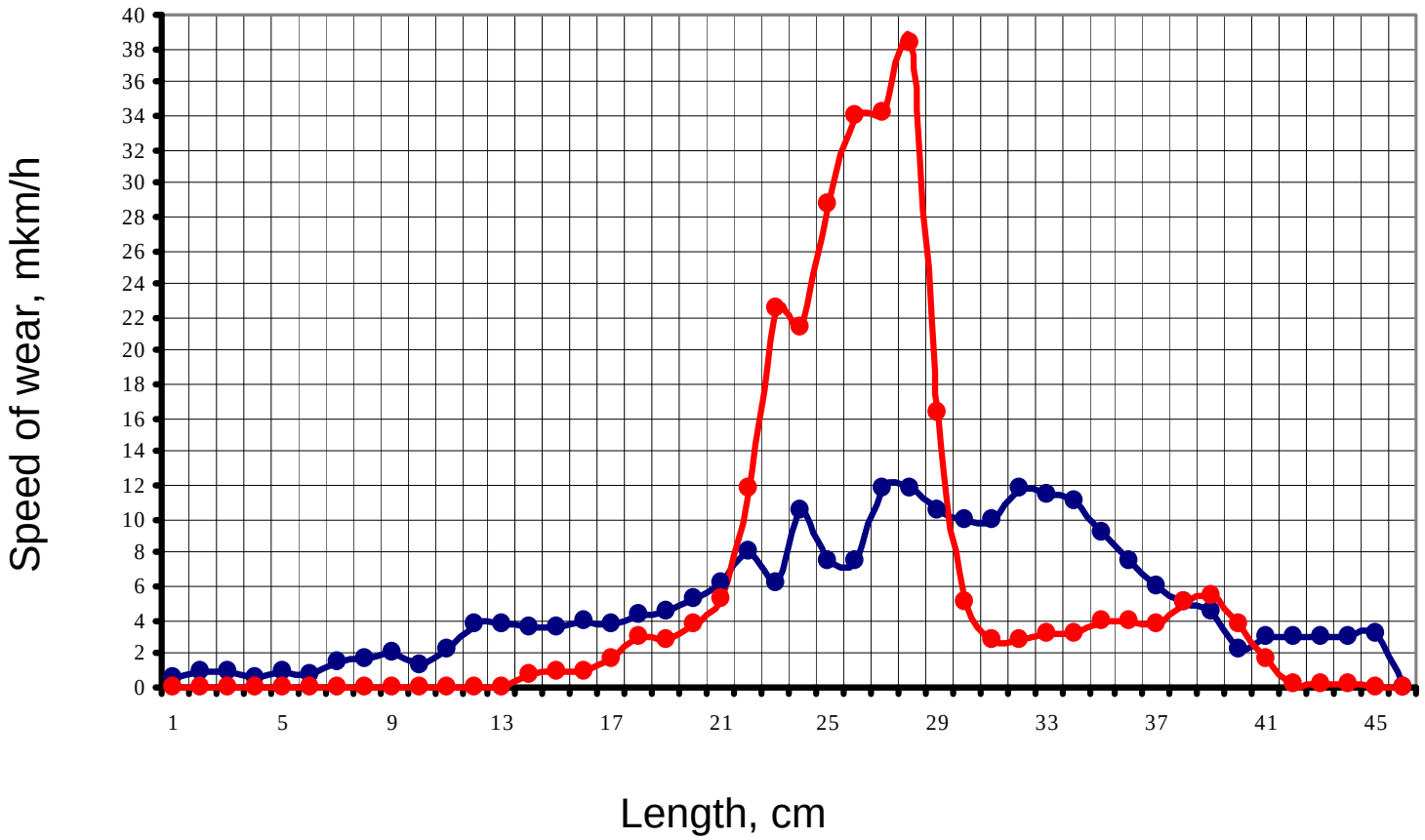


- Maximum solids concentration is in the area of vortex impeller.

- At 1900 BPD flow rate solids concentration in the critical area is 8 times as much than concentration of the injected solids, and 11-14 times as much at 950 BPD flow rate.

No gas – bigger wear

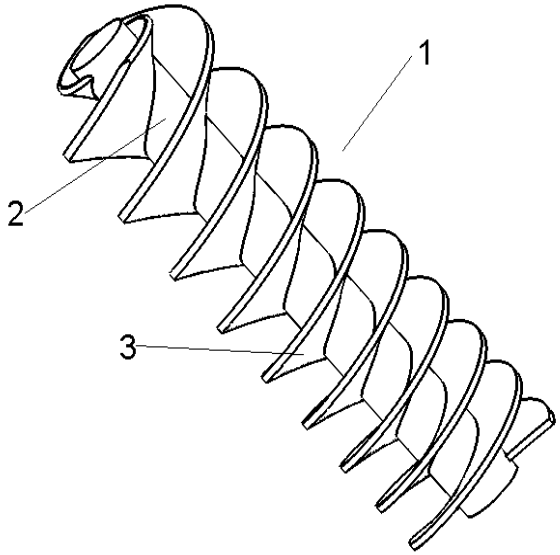


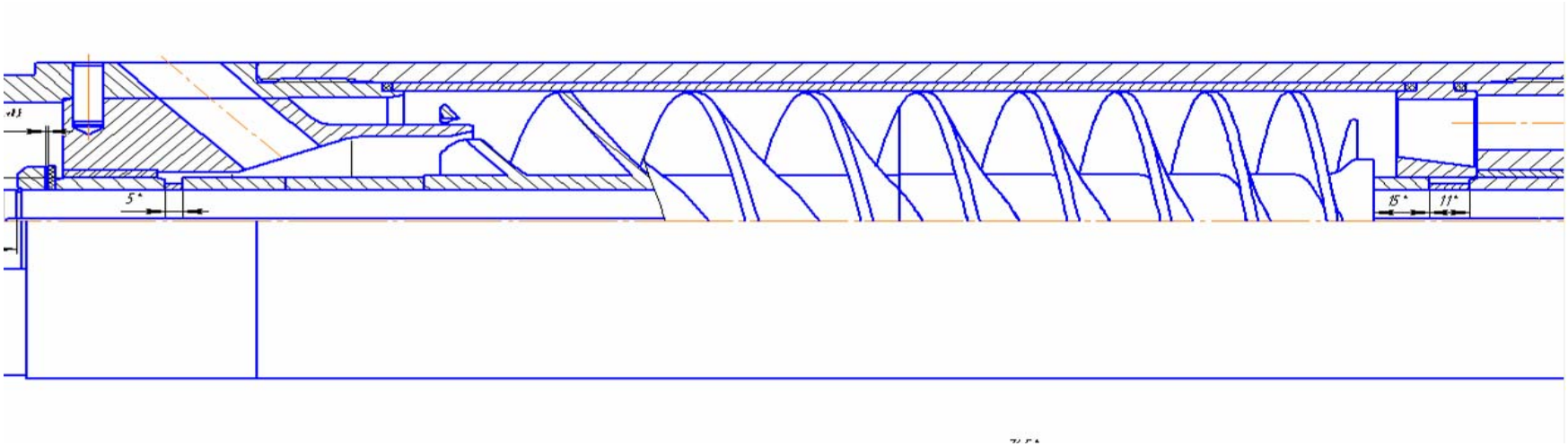
Blue – 20% gas, red – no gas

New Gas Separator design

Helical inducer of varied pitch **1**,
containing sleeve **2**
with spiral vanes **3**,
inclined toward the fluid flow

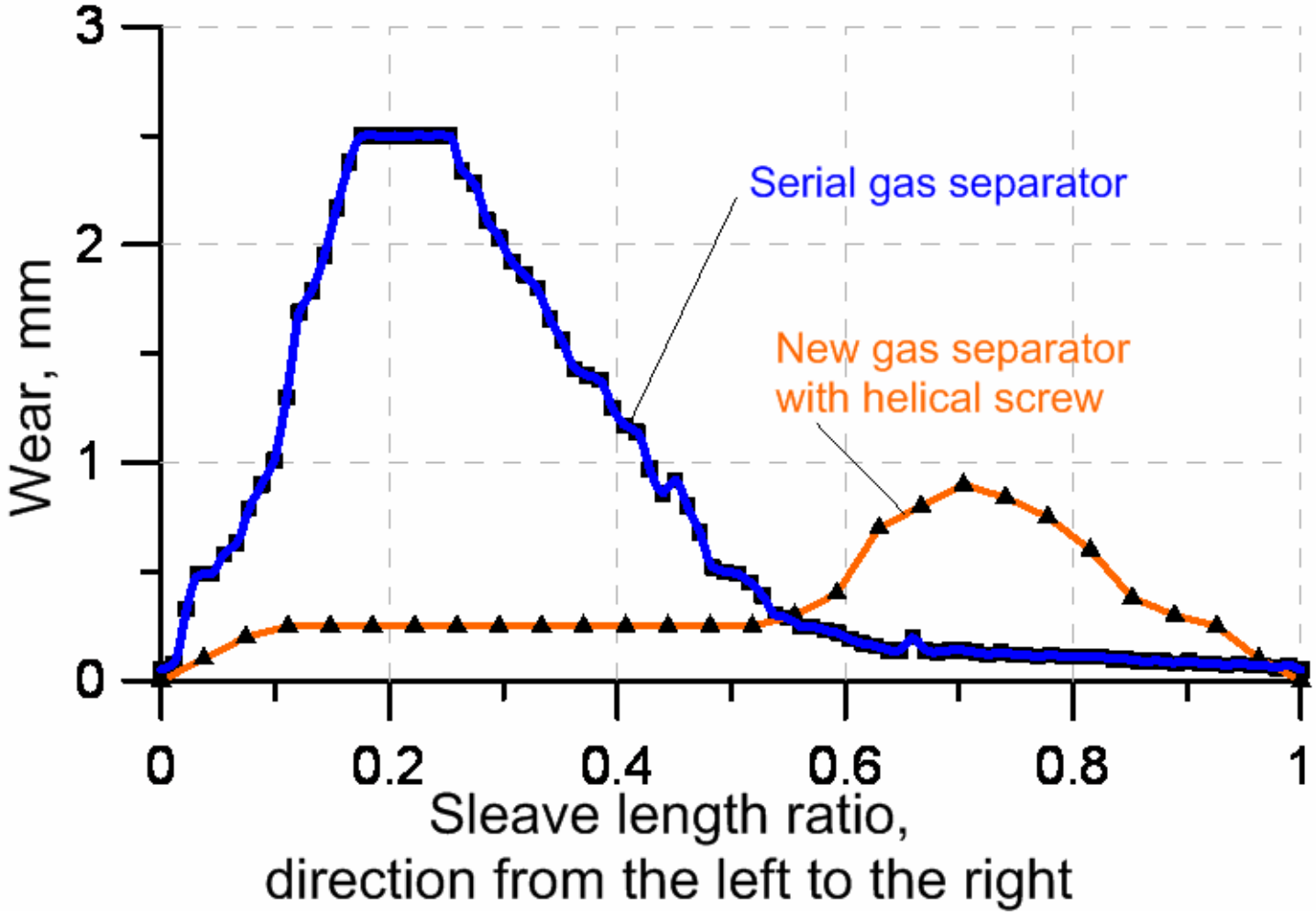
Pumping and separation units are combined





Results Achieved

•Dependence of sleeve thickness along its length after 100 hours of Hydro-Abrasive testing on test bench at equal flow rate 500-630 BPD



Actual Experience

- Wide experience: since 2006 more than 1420 abrasion resistant gas separators were supplied to the Customers
- Application of such gas separators helped to eliminate the problem of housing cutting by abrasive flow

High GOR Solutions

Application of Gas separators

Challenges/limitations:

1. Extremely gassy wells
3. Producing in non-venting conditions
4. Deviated/horizontal wells

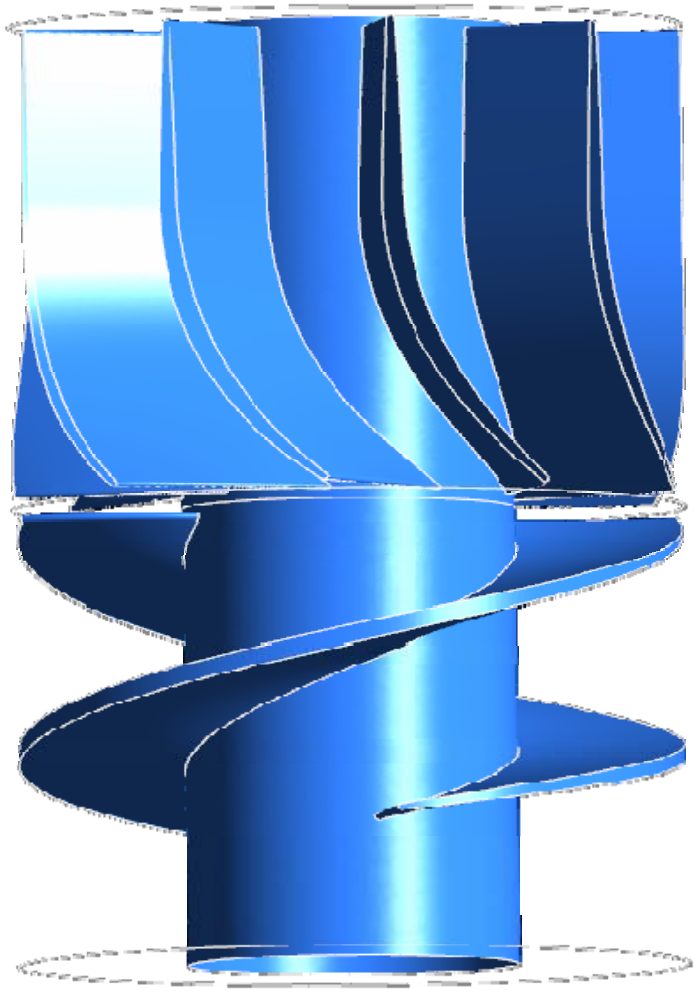
Solutions

1. Application of Multiphase Pump

Multiphase Pump Application

What does it do?

- Homogenizes the fluid
- Pushes gas-liquid mixture thru Main ESP stages
- Drastically reduces a possibility of pump to Gas Lock at low Pi



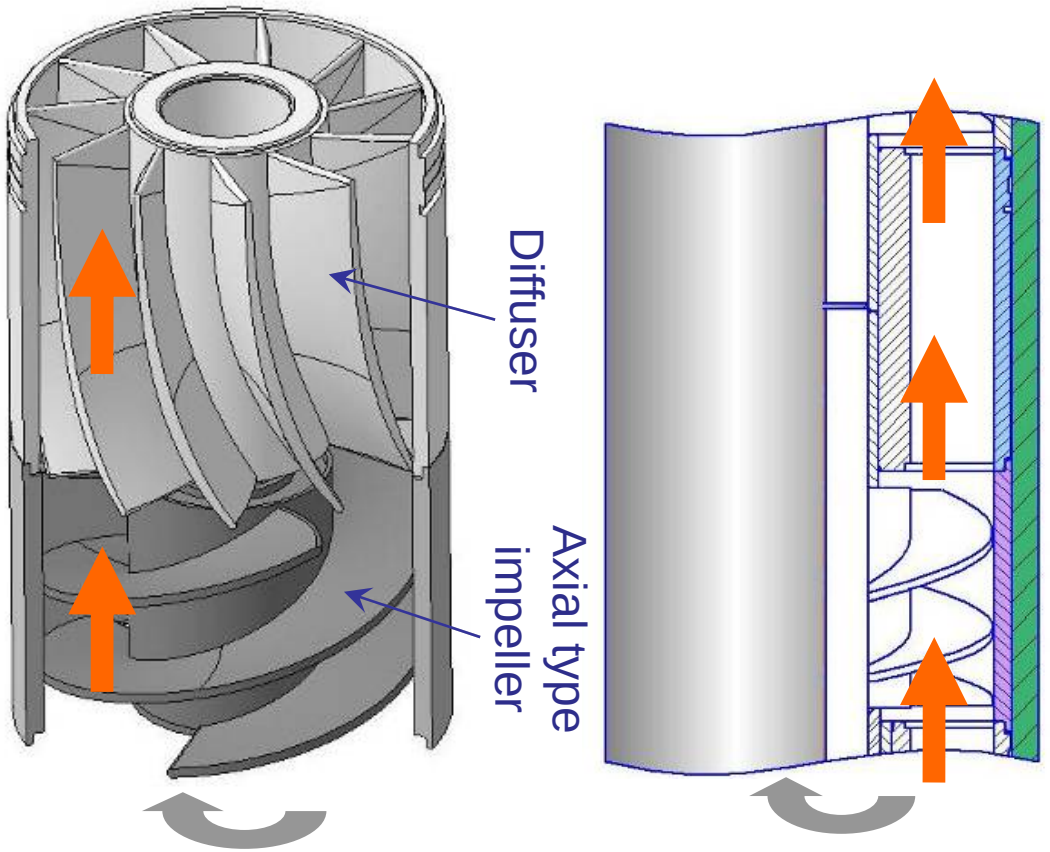
How does it work?

MPP stage design has axial screw type impeller and gas handling diffuser

Operation:

1. Flow streams to the axial type impeller → gas volume is compressed
2. Compressed gas streams to the diffuser → gas bubbles break into small

Result: homogeneous gas-liquid mixture



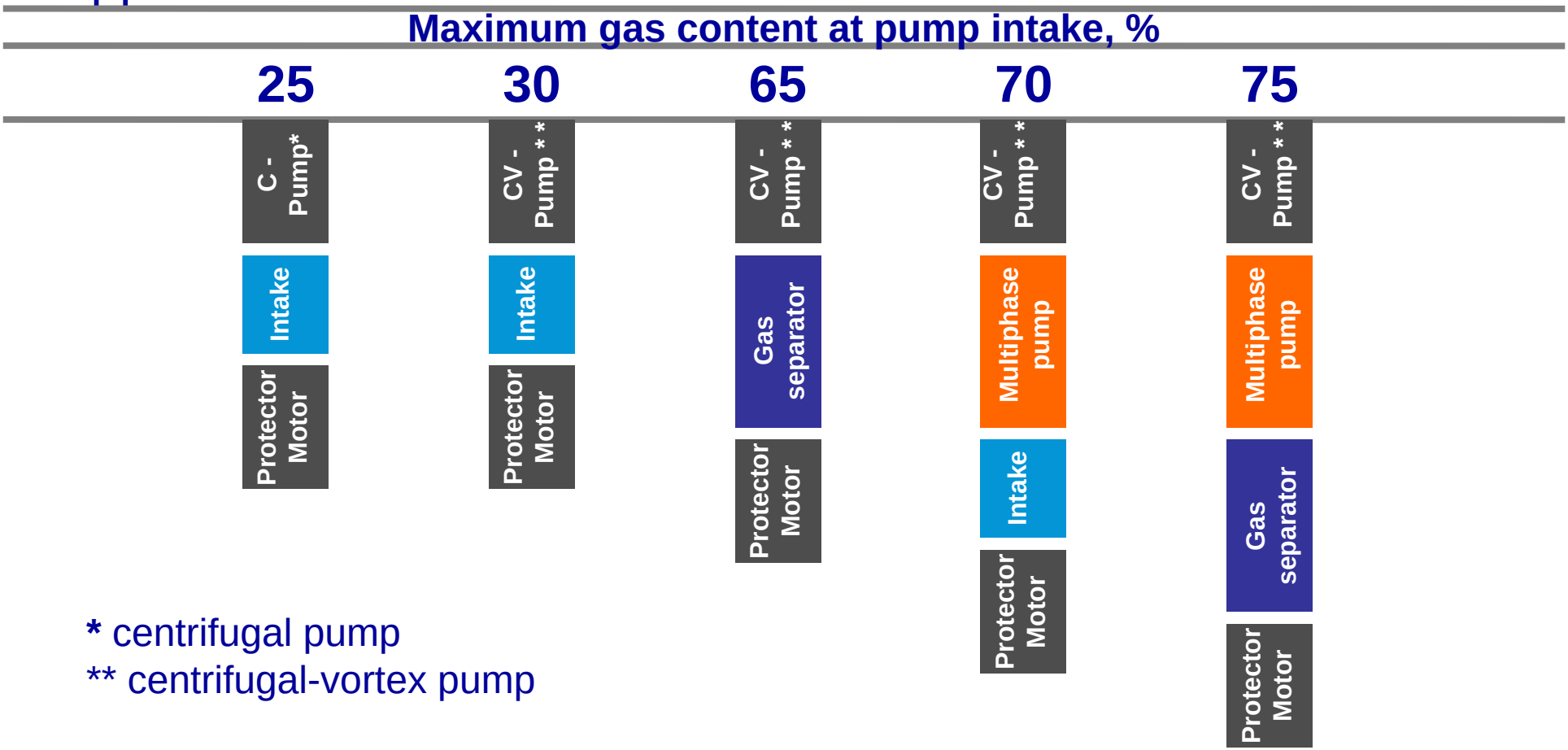
MPP primes the Main ESP and pushes the gas-liquid flow into centrigugal stages with no gas locks

ESP Sizing considerations when using MPP

- ✓ MPP flow capacity should be not less then main pump capacity
- ✓ Pump Head degradation
- ✓ Better to use ESP with vortex-type stages.

ESP system designs for gassy fluids production

Test results for different ESP configurations achieved on working fluid (water+gas+surface-active substance) imitated reservoir fluid properties on Test bench for gas handling application

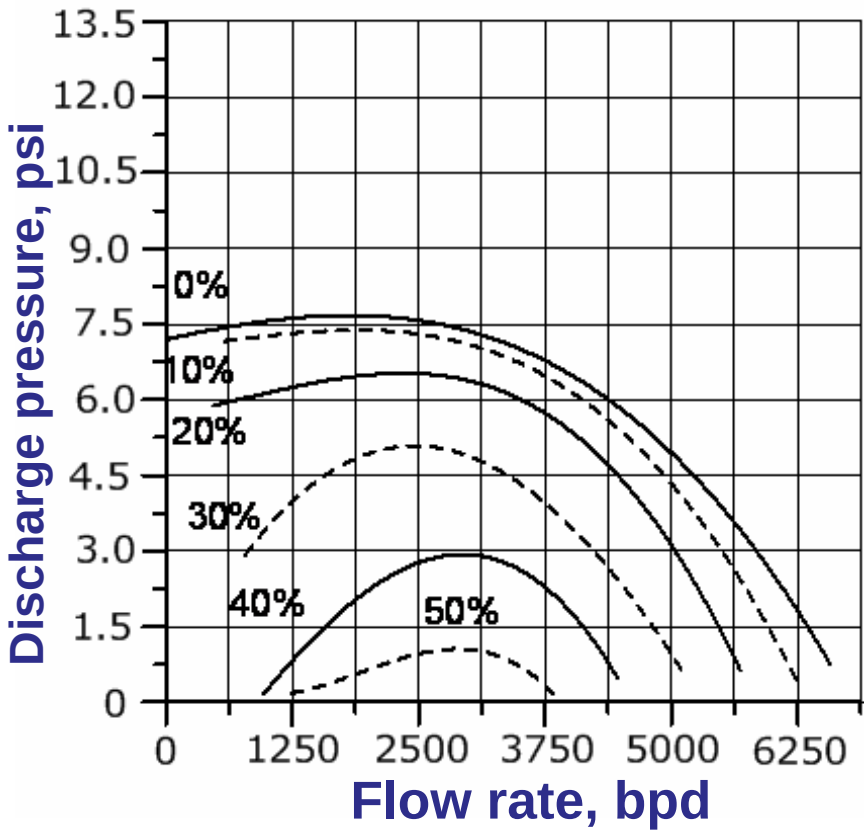


***** centrifugal pump

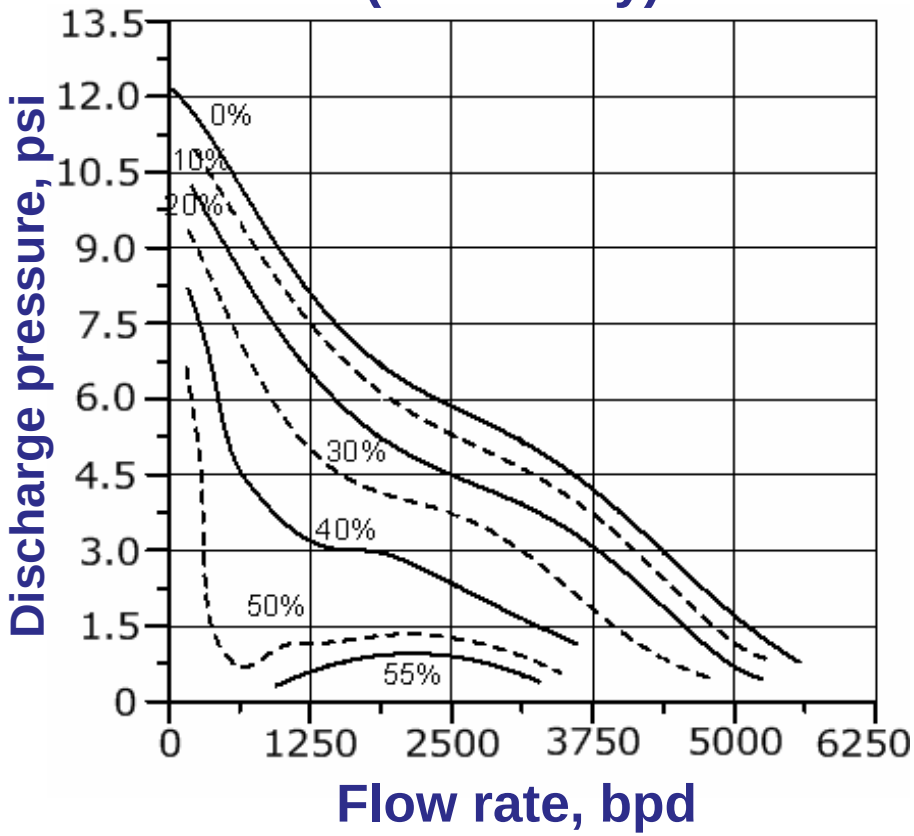
** centrifugal-vortex pump

ESP Vs. MPP

ESP: OD 4.06”, 3145 bpd (500m³/day)

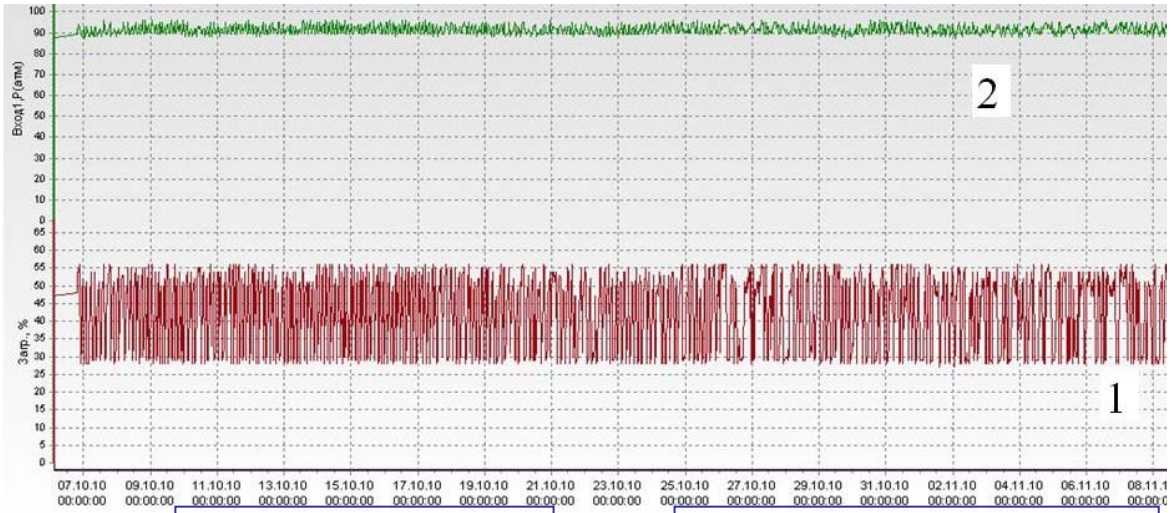


MPP: OD 4.06”, 3145 bpd (500m³/day)



MPP has stable and wide range operation (even at low intake pressure) vs. ESP performance

Motor current analysis

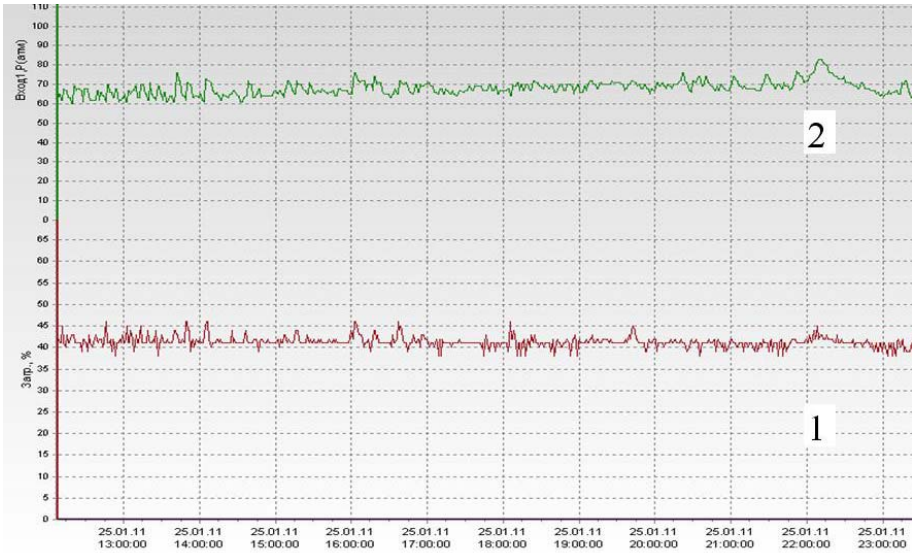


ESP without MPP:

1 – motor load, 27-55%

2 – bottom hole pressure, 1300psi (90atm)

Gas pulses at pump intake → Unstable mode of motor operation → ESP system reliability decreasing



ESP with MPP:

1 – motor load, 42%

2 – bottom hole pressure, 1000psi (70atm)

532 well, Vyngapurovskoye oilfield

MPP operation at different intake pressure

MPP	Max free gas volume up to	
	@ Pi = 40psi (3atm)	@ Pi = 700psi (50atm)
406 series	>40-45%	>60-65%
362 series	>35%	>45-50%
319 series	>30%	>40-45%

The bigger MPP series the bigger volume of gas can be handled

MPP nomenclature

MPP	Flow rate	
	Bpd @60Hz	m^3/day @50Hz
272 series	950	125
319 series	950	125
362 series	1500	200
406 series	940, 2400, 3800	125, 320, 500
449 series*	7600	1000
535 series*	12000	1600

* coming soon

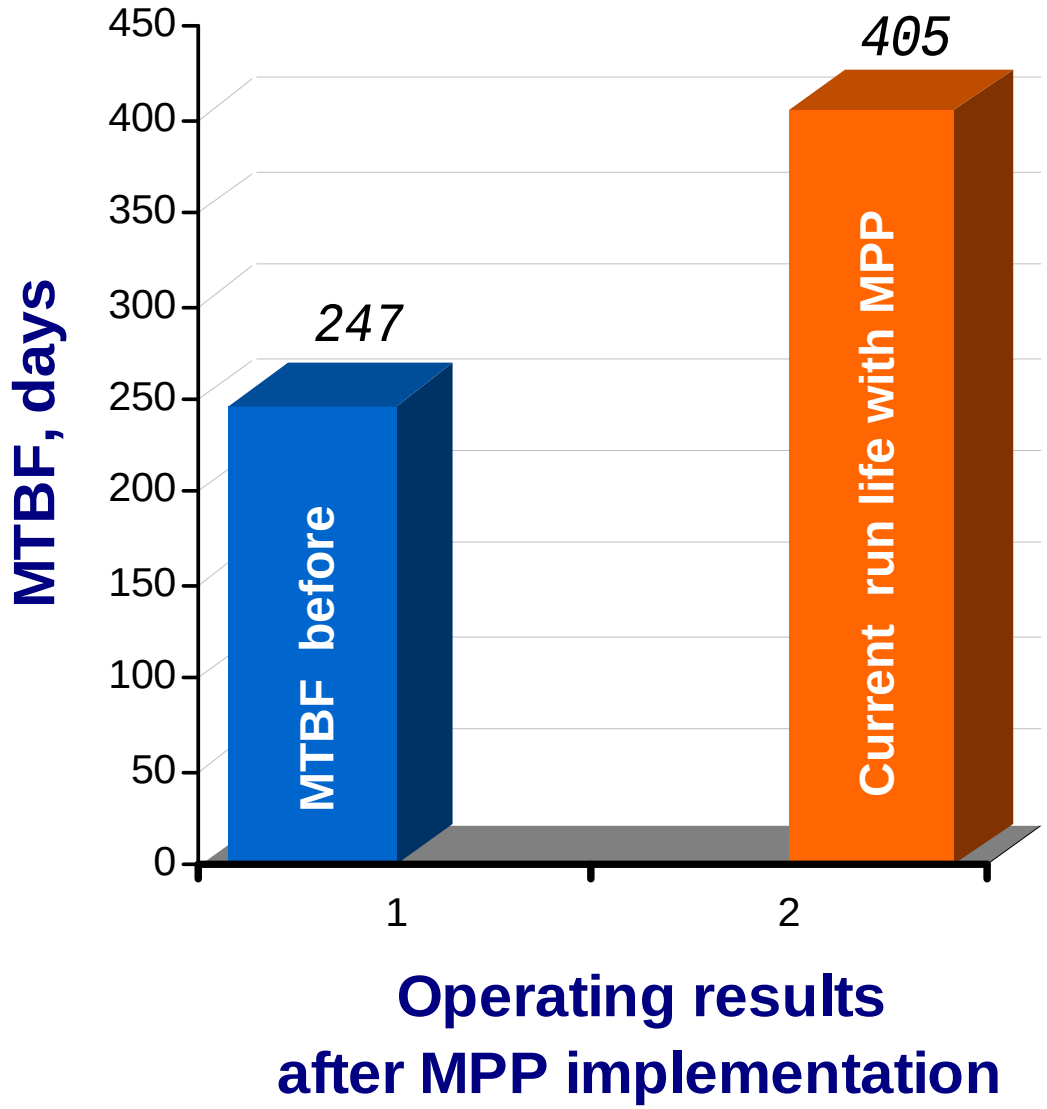
Achieved results:

- Increased production and reservoir life in gassy wells by increasing drawdown and allowing effective pump operation at lower intake pressure
- Due to gas-lift effect greater lift per stage and efficiency are ensured
- Increased production by reducing gas locking production shutdowns
- Extended System Runlife by stabilizing motor current
- Laboratory tests and actual field applications proved MPP to be an excellent solution for high GOR wells
- Wide experience: since 2006 more than 550 MPP were supplied to the Customers

Case study data

- **Customer:** GazPromNeft-Noyabrsk
- **Number of operating well:** 80
- **Problems:**
  - High reservoirs free gas content
  - High number of ESP shutdowns caused by high free gas content
  - No possibility to use gas separator due to under-packer design
  - Wells after interventions

Operating results: MTBF increase



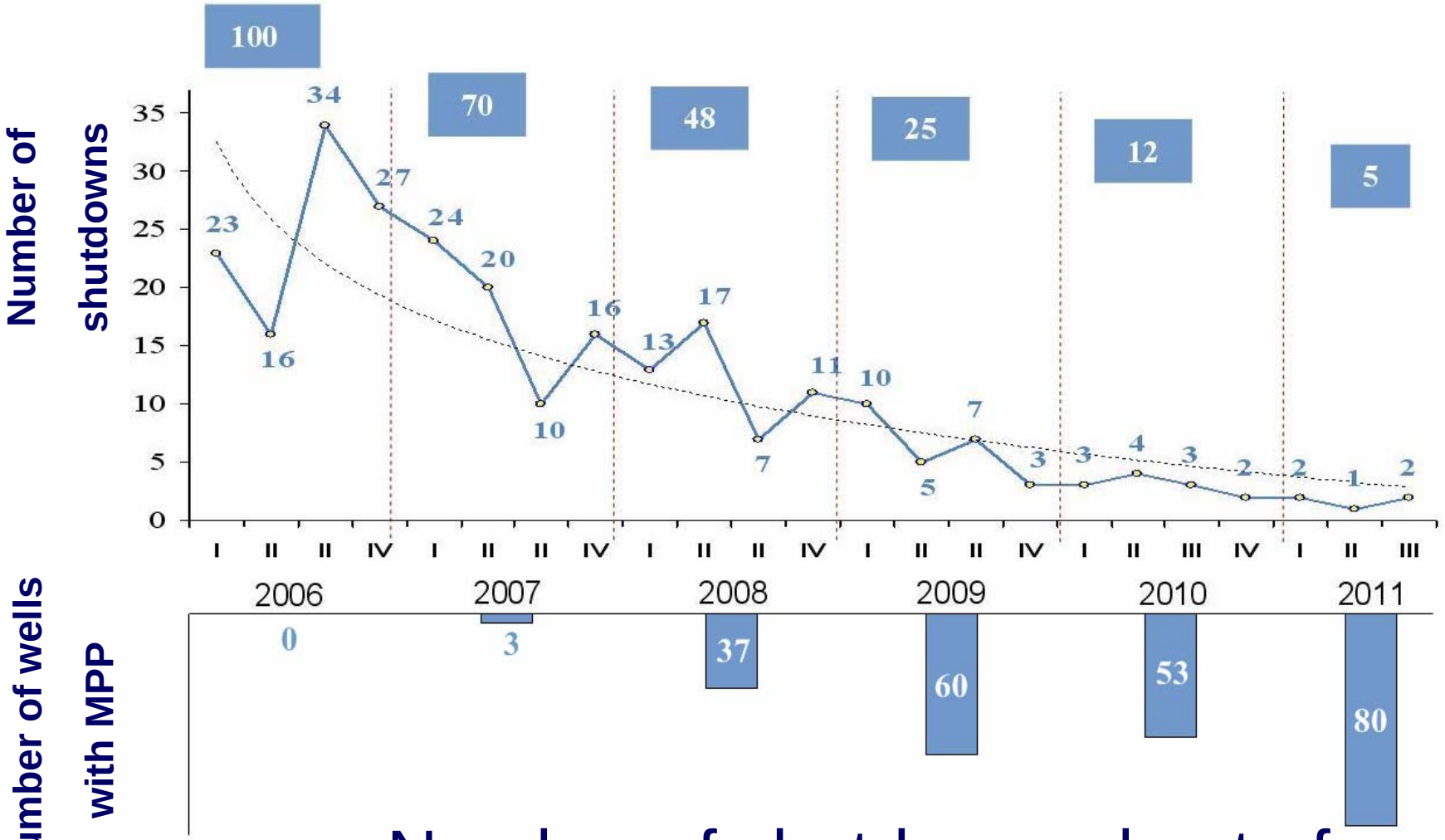
Solution:

Installation of Novomet Multiphase pump to avoid gas locks

Result:

Increase of run life by 230%

Operating results: shutdowns decrease



Number of shutdowns due to free gas content decrease 20 times as less!

THANK YOU !!!