GE
Oil & Gas

# Pump Performance Optimization

## Benefits

- ■■□ Increased production
- ■■■ Higher efficiency
- □□□ Compliance with environmental regulations
- ■■□ Availability and Reliability
- ■■□ Life extension

Customer benefits include:

- Higher efficiency
- Alignment with plant needs
- Solving vibration problems
- Dramatic reduction in operation and maintenance costs
- Energy savings

## What it is

Our customers' most frequent requests relate to match new plant operating points with existing machines originally designed for different conditions.
The most frequent customer needs are:

- **Increasing flow rate**:
  Pipelines, refineries, petrochemical and power plants need to increase their productivity without capital investments.
  Consequently, pumps, as key components of the stream, need to process higher volumes with respect to their design flows. In this situation we are able to design and implement the necessary modifications to meet new operating point objectives while remaining within API operating standards.

- **Increasing Mean Time Between Failure (MTBF )**:
  In order to improve plant efficiency, customers are always seeking to reduce turn down, especially if it is unplanned. In that case we can develop new solutions, redesign components and/or introduce new materials that increase the durability of our machineries.

## What it is

- **Reducing vibrations**:
  Lower vibration levels usually indicate a better machinery operating state, greater MBTF and longer life.
  To keep vibrations at the lowest levels, it is important that the pump operates as close as possible to the Best Efficiency Point (BEP), and many pump modifications are focused on move the BEP to the operating point.

- **Revision of operating point**:
  When significant variations in plant performance are required, it is much more convenient for the customer to have existing machinery modified rather than making changes in the plant layout. Our team has the necessary experience and design tools to reliably reconfigure pumps to match new performance points.

- **Increasing efficiency**:
  It is obvious how increasing efficiency helps to achieve energy savings. Considering that pumps usually operate in continuous service, even a few percentage points of efficiency increase have an immediate pay back on energy savings. This is an area of plant improvement on which to focus.

## How it works

**Customer pump analysis**

The GE Oil & Gas approach starts from a detailed analysis of the existing pump configuration and margins for matching the new target. Then the assessment turns to:

- Establishing the feasibility of the request and how the new target would impact the pump design
- Analyzing the modifications that would be possible to increase the performance of the machine while still complying with API standards

**Pump optimization for customer objectives**

We use a variety of tools for simulating modifications to the pump design in order to validate potential modifications to match the new target point. *Figure 1* shows a scheme of the study approach.

The primary approaches employed are:

- Engineering expertise for similar references: as the Original Equipment Manufacturer (OEM), we carry out all technical appraisals of potential modifications consulting an extensive list of similar references
- Rotor dynamic software: we are able to examine, enhance and verify rotor stability, and evaluate the impact of the upgrade on the rotordynamic behavior of the specific machine
- Computational Fluid Dynamics (CFD) software is used for simulating the design modifications. This allows us to obtain all performance results related to the modifications within an accuracy of 5% (*Figure 1*)
- Our Centrifugal Pump Configurator (CPC) is a web based application integrated with a centralized database that is able to provide us with pump curves based on the calculations from the above mentioned CFD software and test results from the existing fleet (*Figure 2*)

**Solutions**

**Impeller modifications based on the same impeller shape**

- Varying external diameters to shift the Head vs. Flow performance curves upward or downward. The BEP (Best Efficiency Point) is also shifted toward the new operating conditions yielding better efficiency at the operating point

**Modify Curves**

List of Projects  New Configuration  Other Projects  View  Technical Data

| | 0.00 | 0.11 | 0.22 | 0.33 | 0.44 | 0.55 | 0.66 | 0.77 | 0.88 | 0.99 |
|---|---|---|---|---|---|---|---|---|---|---|
| Raked Trim | ● | | | | | | | | | |
| Chipping Volute | | | | | | | | | | ● |
| Underfilling | | | | | | | | | | ● |
| Overfilling | ● | | | | | | | | | |
| Channel Cleaning | | | | | | ● | | | | |
| Cleaning Impeller Inlet | | | | ● | | | | | | |
| Volute Constriction | ● | | | | | | | | | |
| Bull Ring (inlet eye reduction) | | | | | | | | | ● | |
| Orifice 71 | | | ● | | | | | | | |

*Figure 1: Graphic interface of GE Oil & Gas centrifugal pump configurator while simulating modification*

# How it works

- Different trims on impeller vanes (i.e., racked, V-trim, etc.) and/or underfilling/overfilling (*Figure 3*) to modify the shape of the performance curve to better match customer needs (*Figure 5*)

### Change of impeller design

The possibility of installing in the original pump casing an impeller with a new design selected from a wide range of proven GE Oil & Gas impeller patterns in order to achieve the desired performance can be evaluated using detailed simulation tools.

### De-staging or Re-staging

Removing (or adding to a previously de-staged pump) one or more impellers from a multistage pump (*Figure 4*) allows the performance curve to be moved upward or downward, achieving roughly the same effects as modification of the diameter.
Though the BEP position will be different, the most feasible solution with respect to the operating point can be chosen.

### Volute / Diffuser modifications

The geometry of the static channels has a dramatic impact on the performance of a centrifugal pump. Thus modifying parameters such as the volute cross sectional area, the position of the volute cutwater, and the shape and distance of the cutwater to the impeller provides significant flexibility in the shape of the performance curve.
A CPC analysis gives a range of suggested modifications to achieve a defined operating point.

### Volute cleaning and coating of the casing with ceramic paint

Saving energy is a key issue in plant operations today. In centrifugal pumps, the efficiency is directly affected by the friction encountered by the process fluid as it passes through the pump. For this reason optimum surface finishing is required to reduce friction.
Further reduction can be achieved by applying specialized ceramic coatings along all the channels. A recent introduction in the pump industry, this process produces very positive results with regard to the ability to reach and treat even very narrow areas such as impeller vanes in multistage pumps which cannot be reached for polishing.

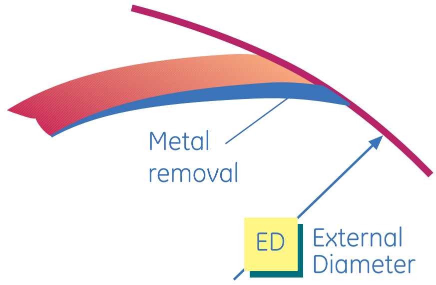



*Figure 3: Metal removal on impeller*

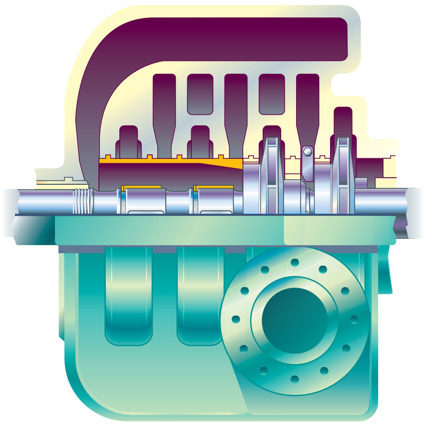


*Figure 4: Destaged pump*

## Performance Curves

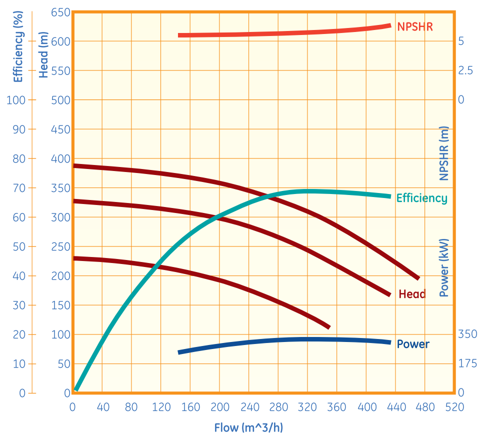



*Figure 2: Centrifugal Pump Configurator (CPC)*

| | |
|---|---|
| Proposal No | * |
| Item No | * |
| Selection No | |
| Date | * |
| Pump Size & Type | 8x14-DS THF |
| Number of Stages | 2 |
| Curve Reference No | Sp-240 000/000/000 |
| | 42876/SD |
| Impeller 1st stg. | 42825÷29/1881-H |
| | 54126/SD |
| Impeller 2st stg. | 25625/3056-H |
| Rated Impeller Diameter | 330.9 mm |
| Max Impeller Diameter | 355.6 mm |
| Min Impeller Diameter | 279.4 mm |
| Eye Area | 390.32 cm^2 |
| Specific Speed NS (US) | 1209 |
| SSS (US) | 9499 |

The pump is guaranteed for the following set of performances with H2O. Performances plotted at other capacities are approximate.

| | | |
|---|---|---|
| Applicable | API 610 X Ed. -ISO | |
| 13709 | | |
| Standard | 2005 | |
| Rated Capacity | 346.0 | m^3/h |
| TDH | 230.0 | m |
| Rotational Speed | 2980 | RPM |
| NPSHR 3% @imp. CL | 5.5 | m |
| Rated Efficiency | 67.8 | % |
| Rated Power@SG=1 | 319.9 | kW |
| Rated Power | 290.3 | kW |
| MCSF | 146.4 | m^3/h |
| Pumped Liquid | | |
| Operating Temp. (O.T.) | 355.0 | deg C |
| Specific Gravity@ O.T. | 0.901 | |
| Kinematic Viscosity | 6.0 | cSt |
| Viscous correction factors: | | |
| CE: | CQ: | CH: |
| 0.993 | 1.0 | 1.0 |

*NPSHR= Net Positive Suction Head Required*

*Starting from the customer's request, the system analyses the data and suggests the best solution*

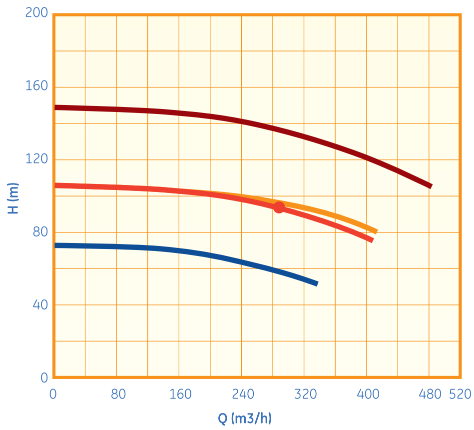
# How it works

## Pressurized throttle bushing and/or clearance modifications

Our extensive experience with rotating equipment has led to the development of specialized rotor dynamics capabilities. Using advanced software to simulate rotor behaviour has shown that some vibration problems can be solved by changing the stiffness of the rotor support. One of the latest innovations is a back-pressurized throttle bushing. In this case, fluid from the discharge is conveyed to the back of the throttle bushing providing a very stiff rotor constraint. In many cases vibration levels can be substantially decreased with this solution.

## PEEK (Poly-Ether-Ether-Ketone) wear rings

The use of composite materials as wear components in centrifugal pumps offers in many cases the most innovative and cost effective solutions. A composite consist of two or more distinct materials that when combined create a material that is stronger, tougher and/or more durable than the individual materials standing alone and that has excellent strength and wear properties (*Figure 6*). Using these materials it is possible to reduce clearances between rotating and stationary wear parts, which leads to a multitude of performance advantages such as increased MTBF and enhanced efficiency.




Maximum diameter curve

New shape of curve at rated diameter after valute modifications

Original curve at rated diameter

Minimum diameter curve

*Figure 5: Impact on perfomances due to volute modifications*

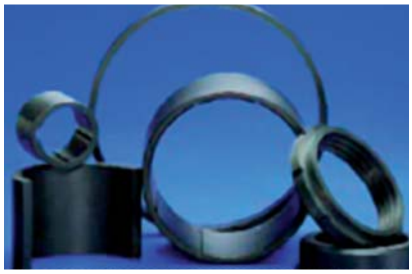


*Figure 6: PEEK wear rings*

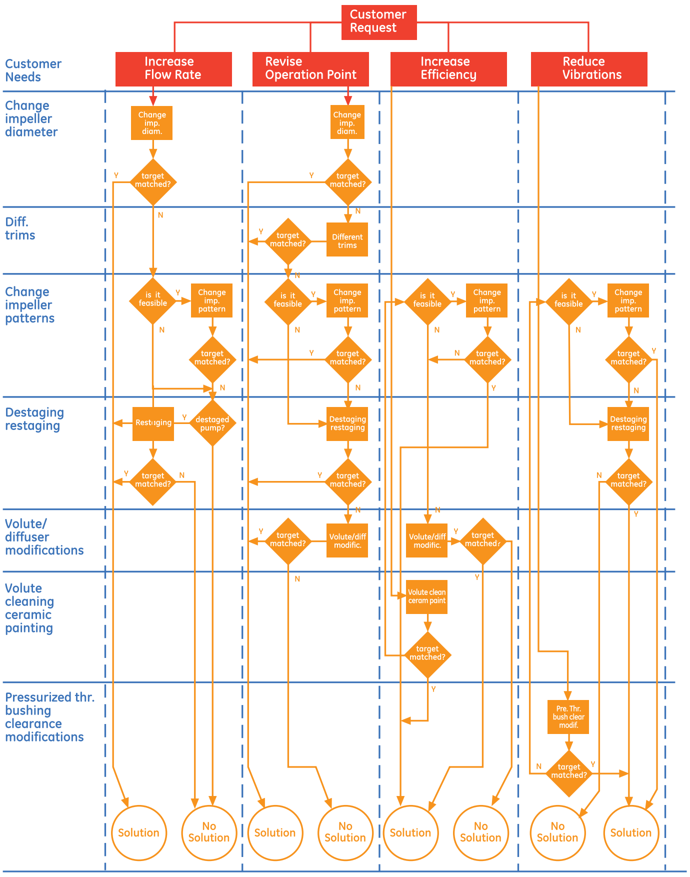



*Figure 7: Workflow from customer request to solution*

GE imagination at work


GE Oil & Gas
via F. Matteucci, 2
50127 Florence - Italy
T +39 055 4272500
F +39 055 4232800

Nuovo Pignone S.p.A.

E customer.service.center@ge.com
www.ge.com/oilandgas



COMK/MARK 839/II - Designed by: Studio Tre Fasi
Printed by: Sagraf - 1-2008