Reprinted from August 2015

Engineered Composites Offer Opportunities for Upgrading Equipment

These pumps prevent equipment from corroding, provide lower costs and increase efficiency.

BY **JOHN A. KOZEL**
SIMS PUMP VALVE COMPANY, INC.

Engineered composites can be designed and used to improve performance and efficiency as well as reduce maintenance and repair costs. Composite upgrades prevent expensive products from deteriorating, extend the life and reliability of existing equipment, and increase pump efficiency. They can even prevent pump leaks that can result in costly cleanups and fines from regulatory agencies. In most cases, reduced downtime resulting from introducing structural composite pump upgrades is one of the most important benefits.

The impeller is the heart of any centrifugal pump. Like a human heart, a pump impeller is the most critical pump component, constantly stressed by hydrodynamic forces, fatigue, corrosion, erosion abrasion, chemical attack and cavitation. The overall efficiency of a centrifugal pump is in direct correlation to the efficiency of the impeller. To maximize efficiency, the impeller's hydraulic design must correspond to the design of the pump casing and to the operating conditions of the pump in service.

Any centrifugal pump can be made energy-efficient by upgrading the impeller and rings to an optimized and engineered composite, such as one company's structural graphite epoxy composite. This company offers impeller and ring upgrades for any centrifugal pump, which provide higher efficiencies and increased longevity. They can also design the impeller so that the operating point becomes the best efficiency point (BEP).

Image 1. Structural composite upgrades can extend pump life, improve performance and increase efficiency. *(Images and graphics courtesy of SIMS Pump Valve Company, Inc.)*

When companies are trying to save money, it may seem difficult to justify the upgrades, but the payback for pump upgrades is extremely quick—usually less than one year return on investment.

In most cases, the incremental costs of upgrades are minimal when compared with the loss in downtime, energy and expensive repairs. Plant outages, ship overhauls, building new vessels, constructing new manufacturing plants, plant expansions and new system installations are good opportunities to upgrade existing pumps to composite internals and specify pumps with upgraded efficiency and reliability features.

As equipment starts to age, pumps lose performance and efficiency. They also require additional maintenance, repairs, expenses and downtime. Often, the aging or corroding equipment cannot keep up with plant demand. Before equipment gets to this point, pumps can be upgraded to structural composite to extend the life of the pump, return the pump to the proper performance and increase efficiency.

Pump Optimization

Too often, a pump is purchased for a specific performance but when put into service, it operates at a point completely different from the original design point, or BEP, because of the system requirements. The pump operating away from the BEP also causes problems such as excessive noise and vibration, shaft oscillation, cavitation, and premature wear and failure of the mechanical seals, bearings, rings, sleeves and impellers.

In extreme cases, the pump shaft will break right behind the impeller from the excessive radial forces that occur when a pump is operated away from the original design point.

Operating a pump away from the BEP has a detrimental effect on pump efficiency. The larger the pump, the more energy is wasted. Operating any pump away from the BEP wastes a tremendous amount of money, because an estimated 85 percent of the total cost of owning a pump is the operational cost (maintenance cost plus the cost of energy).

Fortunately, these problems can be easily resolved by installing engineered structural composite impellers and rings, which have been re-engineered for the system's requirements. The reliability and longevity of the complete pump is also substantially improved.

Image 2 shows two severely deteriorated impellers in a two-stage horizontally split-case cooling pump in a power plant. They were underperforming and were terribly inefficient. A 75-kilowatt (kW) motor operating in this condition could easily lose 50 percent of the original efficiency.

If the original efficiency was 80 percent and now the pump is operating at 40 percent efficiency, there would be an approximate loss of $31,104 per year at $0.12 per kilowatt (kW) hour (see Equation 1).

30 kW loss x 8,640 hours x $0.12/kW hour = $31.104
Equation 1

Even if the pump was operating only 10 percent away from the BEP, the approximate loss would be $7,776 per year, plus additional maintenance expenses (see Equation 2).

7.5 kW loss x 8,640 hours x $0.12 kW hour = $7,776.00
Equation 2

The composite pump in Image 4 was re-engineered into a two-stage structural composite pump with single-suction impellers. It is approximately 11 percent more efficient than the original metallic pump (before corroding), and this new composite pump will never corrode. All wetted parts are manufactured with structural composite, and the bearing frames are machined from type 316 stainless steel.

Image 2. Two severely deteriorated impellers in a two-stage horizontally split-case cooling pump

Improved Efficiency

In 2015, tremendous effort has been put forth to reduce energy consumption. The Department of Energy (DOE) and the Hydraulic Institute have been working together to reduce the energy consumption of pumps, motors and pump systems. Engineered composites can contribute to this effort. By re-engineering the pump/impeller design, they can significantly reduce energy consumption—in some cases by 20 percent.

Equipment Longevity

In addition to improved efficiency, engineered composite impellers offer many advantages over traditional products cast from metal. They do not corrode, are lightweight, can run with tighter clearances, are designed for high efficiency, and are not subject to casting defects or imperfections.

Many of these impellers and casing rings have been used successfully since 1955 in the Marine, Navy, wastewater, industrial and chemical markets. Structural composite impellers have often outlasted and outperformed products manufactured from bronze, stainless steel, duplex steel, monel and even titanium.

Reduced Wear

The new alternative composite solutions for impellers and rings are ideal for new, repair or retrofit applications. Engineered impellers and rings are lightweight and do not corrode.

Wear of other pump parts—including the pump casing—is greatly reduced because of the engineered impeller's balance, light weight, self-lubrication, sealing, and resistance to corrosion, erosion and cavitation. This means far less expense for replacement of parts and downtime. Reducing or eliminating corrosion, erosion and cavitation can increase efficiency and reduce costs substantially.

Maximized Performance

Because of new technologies, structural composite impellers are computer-engineered and precision-machined. The impeller vane geometry can be engineered using computational fluid dynamics (CFD) techniques and programmed to maximize efficiency and performance. Problems such as recirculation, radial thrust and cavitation can be minimized or eliminated by using structural composite impellers instead of the traditional metallic ones. Impeller vane shapes can easily be modified to provide the best vane shape for specific applications and performance requests.

Corrosion, erosion, cavitation, rotor imbalance and leakage between the wear rings, casing rings and interstage bushings are major contributors to the loss of pump efficiency. Damage from corrosion, erosion and cavitation quickly destroys the metallic pump parts. Because of the self-lubricating characteristics of many engineered composites and because composites do not wear or corrode, the performance curve will actually increase over a period of time. A 1,000-hour performance test was completed on a U.S. Navy Standard Fire Pump manufactured from titanium with one company's engineered structural composite impeller and casing

Image 3. Damage from corrosion, erosion and cavitation can quickly destroy metallic pumps and pump parts.

Image 4. This composite pump was re-engineered into a two-stage structural composite pump with single-suction impellers. It is approximately 11 percent more efficient than the original metallic pump (before corroding).

Image 5. This vertical in-line structural graphite composite pump replaced the type 316 stainless steel pumps onboard the Navy Military Sea Lift Command Vessel.

rings. The result showed a 2.5 percent increase in the head-capacity (H-Q) at the end of the test.

One of the many advantages of using composite pumps is that the casing volute geometries and the impeller geometries can be designed and engineered specifically for the required operating point in the plant or vessel.

With premium efficiency engineered structural composite pumps, strength can be added and removed based on need.

Premium efficiency composite pumps are designed and engineered to keep their overall sizes at a minimum so that they can easily fit into confined spaces. These types of pumps are also engineered to minimize piping modifications while maintaining or exceeding pump performance. These engineered composite equipment upgrades help pump users increase the efficiency and longevity of their pumping systems. ■

John A. Kozel is president and CEO of SIMS Pump Valve Company, Inc. He may be reached at 201-792-0600 or at simsite1@aol.com. For more information, visit simsite.com.