DuraFlow™

Corrosion-Resistant Flow Dividers

ROPER PUMPS®

DuraFlow™ Corrosion-Resistant Flow Dividers

Roper Pump Company's Latest Liquid Fuel Flow Divider Designs Guard Against The Most Common Causes of Failure

New Technology Delivers Reduced Life Cycle Costs

- Maximum uptime – Higher turbine availability increases revenue.
- Dramatic cost reductions for plant operation and maintenance budgets
- Resistant to corrosion during standby (or while turbine runs on natural gas)
- Higher reliability during startup of liquid fuel systems
- Resistant to failure from particulate contaminants in liquid fuel
- Low viscosity fuel applications

For years, flow dividers have been used on many gas turbines as an efficient means of maintaining equal flows of liquid fuel to all combustors. Flow dividers are passive devices that derive their motive power from the energy contained in the flow of fuel delivered to them by the main fuel pump. Although the designs and layouts vary somewhat, the fundamental principle of operation of flow dividers is the same. They are actually little more than an array of virtually identical, high-precision, spur gear hydraulic motors (i.e. flow elements) that are mechanically coupled together to run at equal rotational speeds. When liquid fuel flows into the flow divider, it simultaneously exerts pressure on the inlet side of all these hydraulic motors, which causes them to rotate and meter fuel at virtually identical discharge flow rates.

To maintain relatively equal discharge flows under varying pressure conditions, the running clearances inside each flow element must be extremely small. This characteristic also makes flow dividers very susceptible to fouling if particulate matter is permitted to enter these clearance areas. Particles greater than 20 microns (.0008 inches) must be filtered out. Certain non-particulate fuel impurities that cannot be filtered out are another potential source of problems. Liquid fuels may contain various corrosion-causing contaminants that are capable of attacking the materials that flow dividers have traditionally been made from. One of the most common contaminants is water. If a flow divider remains idle for an extended period of time, filled with distillate fuel, entrained water in the fuel will separate out and settle in the lower recesses inside the unit. The water will react with the cast iron flow divider components and form iron oxide corrosion products on all wetted surfaces. The growth of these iron oxides can quickly consume the small clearances between the gears and housings and prevent rotation of the flow divider. This is the most common cause of flow divider failure in applications where dual-fuel turbines are run on natural gas for extended periods of time without regard for proper preservation measures. During operation on natural gas, the liquid fuel system is non-operational and the flow divider often remains filled with a stagnant volume of distillate fuel. Under those conditions, rust can quickly form on the surfaces of the housings that surround the gears, growing in volume until it prevents rotation of the flow divider. This condition can go unnoticed until a subsequent transfer from gas to liquid fuel operation is attempted. At that point, if the flow divider cannot break away, the turbine will trip due to a loss of fuel flow.

Corrosion caused by water in fuel from leaky check valves

Gears fused to corroded case

Problems Encountered with Older Flow Divider Designs

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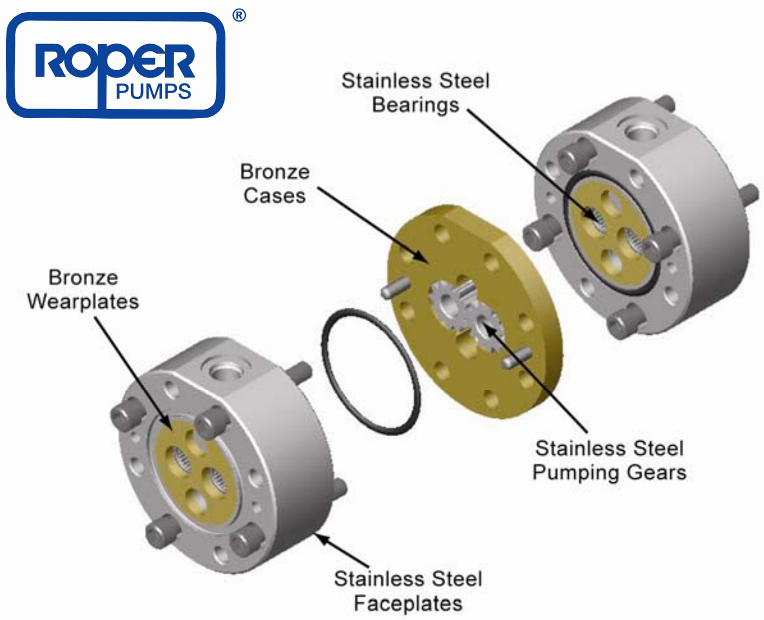
The prevention of corrosion in liquid fuel flow dividers has historically been one of our greatest challenges. Simple maintenance techniques, when properly applied, are very effective in minimizing such corrosion-induced failures. The problem is that, in practice, these procedures are often not adhered to by end users. For this reason, an inherently corrosion-resistant flow divider design that requires little or no maintenance has long been an elusive goal. Over the years, incremental improvements in corrosion resistance have been realized by making components such as pumping gears, drive shafts, and bearings from stainless steels. Nickel and chrome plating of other components has also proven to be very beneficial in corrosion abatement. Flow divider gear housings, though, have traditionally been made from cast iron because of its low cost and certain desirable mechanical properties. Cast iron is easy to machine and its graphitic structure provides very good resistance to both wear and galling when paired with stainless steel gears that operate at relatively low loads and high speeds. The downside of using cast iron, however, is its susceptibility to corrosion. Finding a viable replacement material has long been a major design challenge.



Exploded view of typical element

Cast iron has been completely eliminated and replaced by higher performance stainless steel and bronze components.

Recently, the Roper Pump Co. has developed a new line of corrosion-resistant flow dividers that addresses the problems of both corrosion and fuel-borne particulate contamination. In these new designs, cast iron has been completely eliminated and replaced by higher performance alternative materials. Flow element faceplates are made from stainless steels and incorporate an ingenious system of replaceable bronze wearplates on both sides of the pumping gears. Gear cases are also made from a special bronze. These new materials are virtually unaffected by water in the fuel, so flow divider corrosion should no longer be a major issue. They are also highly durable and wear resistant to help extend service life.

What is more, these materials possess two other properties that help make these new flow divider designs less susceptible to failure should they ingest small, fuel-borne particulate contaminants. First, because of its relatively low surface hardness, bronze can allow any small hard particles that are present in the fuel to imbed, or plough through a running flow element, without precipitating a complete flow divider seizure. Secondly, bronze is an excellent bearing material, making it an ideal choice to make wearplates from. Bronze wearplates have the inherent ability to support stainless steel flow element gears running against them without galling. All these benefits have now been combined into Roper Pump Company's new series of liquid fuel flow dividers. By incorporating superior metals and improved design elements, these units are far more robust and corrosion-resistant than anything available in the past. These new flow divider designs should greatly reduce the incidence of the most common forms of flow divider failure, and lower power plant operating costs by minimizing downtime.

Bill Flavelle
Senior Project Engineer
Roper Pump Company
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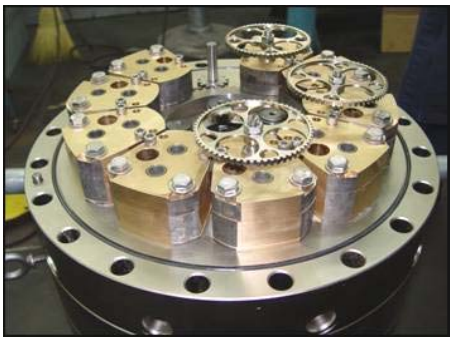
DuraFlow™ Corrosion-Resistant Flow Dividers

20333 Type 1
Frame 9FA Flow Divider



20433 Type 1 CRFD
Frame 9FA Flow Divider

Gas Turbine Applications

Frame 3	W251	M701D
Frame 5	W501D5	M501F
Frame 6B, 6FA	W501F	M701F
Frame 7B, 7EA, 7FA	W501G	TG50D5
Frame 9E, 9F		TG20

Key Features

- Stainless steel housings
- Bronze cases
- Replaceable wearplates (bronze or other)
- Stainless steel internals (gears, bearings, shafts)
- All wetted surfaces are protected from corrosion
- 6 to 20 precision machined flow elements
  for equally metered fuel delivery
- With or without speed pickup sensors
- With or without starter motor
- Custom designed to operate in site-specific conditions

ISO9001:2000 Certified

ROPER PUMPS®

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