ADJUSTABLE SPEED DRIVES

Adjustable speed drives (ASDs) offer a versatile method of precise speed control over a wide range.
Many systems use constant speed motors and mechanically regulate process flow using throttling valves, dampers, fluid couplings or variable inlet vanes. These devices generally do not control flow efficiently because energy is dissipated across the throttling device.

Electronic ASDs provide a cost-effective means of matching system performance to the requirements of the process while saving significant amounts of energy. AC variable frequency drives are used with standard squirrel cage induction motors.

Advantages

- precise process control and wide speed range
- reduced maintenance compared to DC systems (brushes and commutators)
- energy savings
- soft starting and stopping with controlled acceleration/deceleration
- reduced noise levels

Disadvantages

- increased cost
- maintenance
- complexity

Drive applications are categorized with respect to power and torque changes in response to the otor's speed. It is important to understand the type of load presented for a particular application because not all are equally good energysavings opportunities for the application of an ASD. In fact, if an ASD is used on some loads there will be little or no energy savings.

Variable Torque Loads

In variable torque load applications, both torque and power change with speed. Torque varies with speed squared and horsepower varies with speed cubed. This means that at half speed, the horsepower required is approximately one eighth of rated maximum. Common examples of variable torque loads are centrifugal fans, blowers and variable discharge pressure pumps.

The use of an ASD with a variable torque load often returns significant energy savings. In these applications the drive can be used to maintain various process flows while minimizing power consumption. In addition, a drive also offers the benefits of increased process control, which often improves product quality and reduces scrap.

Effective speed ranges are from 50% to 100% of maximum speed and can result in substantial energy savings.

Constant Power Loads

In constant horsepower applications the power requirement remains constant at all speeds and the torque requirement varies inversely with speed. One example of this type of load would be a lathe. At low speeds, the machinist takes heavy cuts, using high levels of torque. At high speeds, the operator makes finishing passes that require much less torque. Other examples are drilling and milling machines.

Typically, these applications offer no energy savings at reduced speeds.

Constant Torque Loads

In constant torque loads, the power is directly proportional to the operating speed. Since torque is not a function of speed, it remains constant while the horsepower and speed vary proportionately. Typical examples of constant torque applications include conveyors, extruders, mixers and positive displacement pumps.

APPLICATION CONSIDERATIONS

Most ASD installations achieve their objectives of improved process control, energy savings and reduced maintenance. Their proper selection is dependent on many considerations that are unique to each application. The following outlines a number of areas that should be examined.

Control Options

Each turbomachine type will have a somewhat different relationship of flow to power for various flow-control devices. Available power savings are contingent upon the degree of flow reduction. For example, for a fan requiring a small flow reduction from 100% to 85%, the power saving is nearly identical for ASD control or variable inlet vanes, which may be much cheaper. At less than 85% flow, ASD control becomes increasingly more efficient than other methods.

Constant Head Systems

Not all systems with widely varying flow requirements are good candidates for ASDs. Many systems require constant pressure over a wide range of flows or have a minimum head requirement. Even though flow may be substantially reduced, it may be necessary to keep the turbomachine near full speed to meet the system's pressure requirements.

System Suitability

Knowledge of all points of operation of a system is crucial in establishing whether there is an appropriate match of turbomachine performance and variable speeds selected. Operation of a system at unstable speeds may cause damage to the equipment, the system or possibly both.

Surge Conditions

Surge is characterized by strong pulsations that can be quite violent and destructive. For this reason, the surge region of the performance curve is to be avoided. Systems that have a constant static head may have operating points in a surge region when operated under speed control.

Pump Run-Out Conditions

Installation of an ASD on a pumping system frequently involves the elimination of a throttling valve. When the valve is removed and the pump is correspondingly slowed down it may see very little system resistance. This condition is called run-out and is signified by high vibrations, impeller and seal damage, and piping pulsations.

Shaft Natural Frequencies

Most turbomachines are designed to operate at a speed that is below the first natural frequency of the shaft. In certain cases, high-speed turbomachines are designed to operate between the first and second natural frequencies. A speed reduction for a machine of this type could result in operation at the first critical speed. This would result in high vibration levels and possible failure.

Bearing Problems

Large fans are frequently built with shafts that use sleeve or journal bearings. These fans may have very high breakaway torque requirements, particularly when they have been at rest for an extended period. Selection of the drive and motor should take into consideration this torque requirement to ensure that the necessary requirements can be met.

Reference:
http://oee.nrcan.gc.ca/infosource/pdfs/M92-165_1999E.pdf