[A]

Application : Compressor

A compressor is a mechanical device that takes in a medium and compresses it to a smaller volume. Compressors can either increase or decrease a given mass to a lower or higher pressure. A mechanical or electrical drive is typically connected to a pump that is used to compress the medium.

Compressors have many everyday uses, such as:

- Air conditioners, (car, home)
- Air pumps
- Home and industrial refrigeration
- High pressure car washes
- Hydraulic compressors for industrial machines
- Air compressors for industrial manufacturing

Compressors are used by many industries that depend on the power of compressed gas or fluid to power manufacturing processes of all kinds.

There are several different compressor types:

- **Rotary screw compressor**
  Two helical rotors force gas into a chamber that decreases in size, thereby increasing the pressure of the gas. The screws in the rotary screw compressor can be lubricated with oil or non-lubricated. Oil-free compressors are used for gas that must remain clean and uncontaminated. Rotary screw compressors are typically sized from 30-200 horsepower.

- **Reciprocating compressor**
  One or more pistons are moved inside a cylinder to increase the gas pressure. This is similar to a combustion engine without the ignition of fuel. Just like a car, the pistons generate much heat so the reciprocating compressor is typically cooled by air or water. Multi-stage reciprocating compressors pass the compressed gas from one cylinder to another, increasing the pressure in each stage. Most industrial compressors are multi-stage, ranging from one to 500 or more horsepower.

- **Centrifugal compressor**
  Centrifugal compressors speed up and compress gas via a rotor with blades. Centrifugal force is used to force the air or gas to an outer chamber under higher pressure. Centrifugal compressors are designed to operate above 75-80% speed. Surging can occur below these speeds. This makes the centrifugal compressor ideal for continuous high duty operation.

BENIFITS

-Automatically regulate speed based on load conditions. The drive employs a built-in PID Controller (an external PID device is not required).

-Controlling the number of times the drive fan is switched on and off increases the lifespan of the cooling fan and reduces the need for maintenance.

-With vector control, the system can operate at a stable speed regardless of the load.

-V/f pattern selection saves energy while operating with light load and low speeds.

-The motor continues running even after a 2 second momentary power loss.

-The drive enables different responses to momentary power losses.

-The drive skips over the frequency at which resonance occurs.

-Continuous motor operation at low speed with a minimum speed reference

-The drive can be prohibited from running in reverse by using the Reverse Prohibit Function.

Application Details

AC drive requirements are different for the different types of compressors.

Inlet valve control of **rotary screw compressors** can be simplified through use of AC drive control. Slowing down a positive displacement screw compressor allows the compressor to operate under partial load efficiently. This method can reduce compressor power proportional to output and allow for more efficient operation.

Compressors require a controller to handle varying loads by increasing the speed of the compressor during high demand conditions. Starting torque must be considered in selecting a compressor drive, as the density of the compressed medium may be different for each application. For example, refrigerant density is often much higher at start-up than at operating conditions.

It is typically necessary to oversize a standard drive by one horsepower size because 160% starting torque is often required to start **reciprocating compressors**.

Centrifugal, rotary screw, single-screw, and **twin-screw compressors** have low starting torques accomplished by closing discharge valves, sideload valves, and pre-rotation vanes at shutdown. Oversizing of the drives for these compressors is not necessary, due to the low torque demands at start-up.

KOLORROL drives have features that can benefit compressor applications. A built-in PID controller can automatically regulate speed based on load conditions and eliminate the cost and complexity of a separate PID controller. Flux Vector Control allows the drive to maintain stable compressor speed regardless of load. Automatic Restart features provide quick restart in the event of power failures to keep production process downtime to a minimum. Compressor mechanical resonance points can be avoided by the AC drive by using Jump Frequency points. In summary, overall compressor initial cost and efficiency is improved by applying KOLORROL drives on industrial compressor applications.

[B]

Application Overview: Extruder

Extrusion machines are used to create product by forcing raw material, such as plastic, through a die. Extruders are used to create a wide range of products such as tubing, sheet goods, and insulation. Food processing is a popular application for extruders. Extruders employ a main drive motor to supply power to a screw, which provides the force necessary to push the raw material through the die.

Application Challenges

- Replace hydraulically operated or DC powered drives
- Precise speed control while material is being extruded
- Develop high torque at very low speeds

Allows the drive to operate automatically without setting up an external run sequence.

The drive allows the user to switch easily to different acceleration and deceleration preset times when working with softer mixtures or harder mixtures.

A 17-step Preset Speed Reference is available when working with difficult mixtures of various materials.

The drive is constrained to run within the Upper and Lower Frequency Limits even if a value outside that range is entered accidentally.

A push button UP-DOWN switch can be used to make incremental speed adjustments instead of an analog speed pot input. Use Trim Control function to make fine adjustments to the

	extruder speed.
Overtorque and Undertorque Detection	The drive is capable of detecting the consistency of mixtures and protect the load by using Overtorque and Undertorque Detection. The drive is capable of both protecting the load and detecting any foreign materials introduced to the mixture by setting optimal values for Torque Limits, Stall Prevention During Accel/Decel, and Stall Prevention During Run. The AC drive can automatically restart a Spinning Motor with "Speed Estimation-Speed Search" following a momentary power loss or fault condition.

Application Details

The extruder main drive motor supplies power to the extruder screw providing the force necessary to push the raw material through the die.

KOLORROL AC drives are digitally controlled and designed to develop high torque at low speeds. Since the extruders are often started with the barrels full of dense material; such as plastic, they need to quickly develop a large amount of torque to overcome the inertia.

The precise control of speed offered by KOLORROL allow the operator of the extrusion machine to repeatedly produce products that are within design tolerances. Some features are designed to protect the equipment. Torque limiting controls protect the motor from overload if the mixture's consistency changes.

KOLORROL drives include built-in application expertise. If the operator accidentally enters a value outside of the upper or lower speed limits, the KOLORROL drive continues to keep the speed within limits. Acceleration and deceleration controls allow the operator to easily change from hard to soft mixtures.

KOLORROL AC drive solutions include application programming flexibility and integration to a wide variety of third-party devices. Recipe tables can easily be created offering great flexibility for various product runs. Acceleration and deceleration controls allow the operator to easily change from hard to soft mixtures without ever worrying about specific values.

[C]

Application Overview: Air Handler

Air handlers are used in buildings to control air supply pressure. They include a blower or fan driven by an electric motor, heating and cooling coils, a filter and controls, all housed in a sealed sheet metal enclosure located in a mechanical room, on the roof, or along side the building. They supply conditioned air to the building occupied spaces. Building air volume can be controlled mechanically using dampers or guide vanes; or electrically by controlling blower speed.

HVAC[Heat-Ventilation –Air Condition] systems are sized for the maximum volume requirement making it necessary to reduce blower or fan volume most of the time. Using a Variable Frequency Drive on the air handler to control motor speed reduces the electrical energy consumed by the motor.

Advantages:

- Motors use less energy as speed is reduced
- Drives reduce motor starting current 8-10 times.
- Airflow noise decreases by eliminating starts and stops and reducing air flow.
- Drive avoids running at speeds near system resonant frequency.
- Drives provide low torque starts reducing stress on belts, pulleys and keys.

Start a blower already spinning in either direction due to residual air flow.

Eliminates condensation in motors.

Drives output voltage adjusts automatically to motor load, reducing motor energy use.

Customer choice of rpm, cfm, psi, %

Versatility and simplicity of integrating into building systems

For critical applications where shutdown is not tolerable

Emergency override for critical situations

Prevent system from running when dampers are closed

Application Details

The air handler is part of a system to control building temperature and humidity. There are many variations but the system will always have air handlers. The air handler supplies conditioned air through duct work to individual VAV boxes which control the volume of supply air into the occupied space to regulate the temperature.

The air handler fan or blower changes speed to maintain a constant pressure in the duct work as the volume of air through the blower is controlled by the VAV boxes.

The temperature of the water in the heating and cooling coils controls the temperature of the air supplied by the air handler. The air from the occupied space is returned to the air handler through the return air duct by a return fan or blower controlled by a drive.

The motor is a standard 3 phase, 230/460 volt, 1800 rpm, 1.15 service factor , inverter duty motor sized for the blower horsepower. The blower is sized for the amount of cubic feet per minute needed to control the temperature of the occupied space.

The KOLORROL drives enable air handlers to meet all system requirements.
[D]

Application : Grinder

Grinders are used for cutting or shaping metal parts and providing the properly finished surface. Drives or Motion products are used to maintain constant grinder wheel speed during all phases of the process.

Advantage

- Maintain constant grinding surface speed
- Grind at optimal efficiency while doing heavy or light grinding
- Follow an external encoder to synchronize conveyor with other sections of the process
- Adjust torque to optimal performance as grinding stone dulls or clogs

Constant grinding surface speed can be maintained

regardless of changes to the stone's diameter during the grinding process.

The user can set variable speed levels up to 400

hz.

Arbitrary grinding speeds can be set based on the amount of material to be cut and the grinding wheel type.

Both Frequency Detection and Speed Agree signals can interlock with primary and auxiliary machinery as well as safety equipment while the grindstone is rotating.

Energy Saving Control reduces motor noise and stabilizes the load, perfecting the finishing process. Energy Saving Control allows the motor to run at optimal efficiency and precision when performing light grinding.

Both Overtorque and Undertorque detection settings enable the drive to quickly detect changes as the grinding stone dulls or clogs. The drive can be set to respond to selectable load changes by using Variable Overtorque Detection via the drives Analog input.

Application Details

Heavy cutting is done at slow speed. With a constant wheel pressure on the material to be shaped, the pounds/minute of material removed, or work done, varies with the wheel speed. This is the constant torque part of the profile. After the heavy cutting is complete, a polishing (light cutting) operation is performed. A high speed, lighter wheel-to-material pressure is maintained; therefore, less material in pounds/minute is removed. This is the constant horsepower part of the load profile.

KOLORROL AC drives have features that save energy, which allows the motor to run at optimal efficiency and precision when performing light grinding. Energy Saving Mode also reduces motor noise and stabilizes the load, perfecting the finishing process.

KOLORROL AC drives can automatically detect changes to the amount of torque required during the shaping and finishing phases using Torque Detection. This feedback enables the drive to quickly detect changes as the grinding stone dulls or clogs. This can lead to significant cost savings by prolonging the life of grinding stones.

Motion Control products in precision grinding, such as convex and concave shapes typical in lens grinding require servo control to maintain accuracy on the cutting axis (at minimum).

[E]

Application : Conveyor

Conveyors are used in a broad range of industries and applications to move packaged goods, assemblies, process byproducts, or any material from one place to another. A process designer will typically look for opportunities to use the force of gravity to accomplish product movement. Electric motors are commonly used when gravity cannot be employed or when the speed of a gravitational fall needs to be controlled.

Advantage

- Conveyors requires a good deal of load and speed calculations, combined with actual testing to ensure proper size (power) requirements.
- Acceleration/Deceleration times combined with S-Curve “smoothing” characteristics need fine-tuning to ensure the product is not damaged and/or moved out of position for staging to subsequent processes.
- Care should be taken to ensure proper sizing of a drive’s dynamic braking package or regenerative converter, to prevent drive overvoltage faults.
- Follow an external encoder to synchronize conveyor with other sections of the process
- Coordinate conveyor motion with external machine axes
- Reduce application development time

Offers flexibility of design in modular conveyor arrangements for small horsepower applications.

"Washdown" environmental rating for direct mounting to food processing conveyors

Minimizes peak voltages at motor to extend motor and bearing life in long cable runs.

Control speed of parallel or series conveyors by use of Pulse Train I/O function in the drive. Eliminates the need for complex pulse to analog converter.

The Momentary Powerloss Ride-thru and Fault Restart functions allow the drive to continue operation without the need for attended restart.

Smooth starting and stopping is achieved through the drives Accel/Decel and S-Curve characteristics.

Torque Limit protects the load and other machinery from excessive torque that may occur when the load fluctuates or seizes.

The Zero Servo Function in the Closed Loop Flux Vector Mode makes a mechanical brake unnecessary for tilt-tray and certain incline conveyors that require a mechanical brake to stop.

Operating two or more conveyor motors in series. The load may shift off between motors. The drive allows for load sharing by using Torque Control or Droop Control.

Line regenerative units can be a cost effective option to resistors when sizing high duty braking circuits for downhill or rapid decel applications.

Application

Airports, mines, cement plants, distribution facilities, assembly, and food processing plants all utilize conveyors. Conveyors are typically constant torque loads, meaning the required torque to drive a conveyor is independent of speed. A fixed amount of torque is also required to overcome the frictional, or machine drag, portion of the total load. Conveyors can have nominal amounts of friction and machine inertia for which to compensate.

KOLORROL AC Drives products offer a variety of solutions for conveyors. Utilizing the built-in functionality of KOLORROL controllers provides the highest performance through synchronized, coordinated motion control, capable of easily integrating to third-party devices.

[F]

Application : Machine Tool

Automotive

The Machine Tool application involves the cutting away or eroding a metal casting or block to create a part, using sharp edge tools. It includes a wide range of skills and requires the use of many different types of tools and specialized machines.

Industrial machines are typically installed as capital equipment. Machine tools are key to industrialization of a country. These machines perform such tasks as turning, boring, milling, drilling, tapping in order to machine simple and complex components in many materials ranging from alloys to plastics.

A machining center, for example, will have three or more axes of motion, an automatic tool changer, and will be computer controlled. One of the main parts of a machining center is the spindle head, which holds the tool that is needed to complete a certain task. A spindle is usually belted to an induction motor. Due to the various tasks that are required, the spindle rotates at various speeds and loads. These speed and load requirements can be met using an AC drive in conjunction with a spindle motor.

Various types of machine tools:

- Boring Machines
- Turning Centers
- Broaching Machines
- Machining Centers
- Drilling Machines
- Milling Machines
- Electrical Discharge (EDM) Machines
- Station-Type Machines
- Gear Cutting Machines
- Shearing Machines
- Grinding Machines
- Polishing
- Lathes

Advantages :

- Fast acceleration/deceleration
- Large speed range, high speed operation
- High speed and position accuracy
- Orientation or positioning
- Low maintenance, durability
- Complex I/O interface
- Continuous operation, repeated forward /reverse
- Constant high torque production
- Low vibration
- Fast stopping

Spindle motor can accelerate up in current limit thus providing the fastest acceleration rate possible.

Reduced costs when applying Dynamic Braking in order to achieve fast deceleration

The drive can warn the user of a damaging load related fault situation before it occurs by using Overtorque and/or Undertorque Detection.

This is useful to detect any wear or damage along the cutting blades or bits.

- I/O Interface with numerical controls (NC)
- Multi-function Inputs and Outputs
- Speed Agree Output

Suppress any vibration or instability that occurs when performing light machining for the finishing of the work piece.

Stop at a fixed location

High speed operation for smooth surface finishing

Variable speed levels can be set by the user

with a maximum of 600Hz

[G]

Application: Cooling Tower Fan

A cooling tower extracts heat from process cooling water. Common applications for cooling towers provide cooled water for air conditioning, manufacturing, and electric power generation.

Application Challenges

- Energy savings
- Reduce maintenance requirements (personnel and equipment replacement costs)
- Precisely control process water temperature stabilization

Operate the drive directly with built-in 4-20 mA terminals. Maintain temperature and lower energy consumption.

Set the frequency reference lower limit.

Operation is not interrupted.

The motor continues running even after a (2 sec) momentary power loss.

Eliminate condensation in the motor.

Application Details

A starter and a control unit to provide start/stop control and speed control are required for cooling tower fan operation. KOLORROL AC variable frequency drives are equipped with built-in PID control and speed search technology to restart the drive after a momentary power loss.

For maximum energy savings, the drive should provide the coldest temperature that the system will tolerate before reducing motor speed. Variable frequency drives can be the solution in noise sensitive applications. Soft starting and gradual speed changes make cooling tower noise less noticeable and reduce mechanical wear.

A variable frequency drive can correctly identify the cooling tower fan rotation, slow the motor

speed to zero (when opposite rotation is detected), and accelerate the fan in the correct direction. The VFD drive eliminates brakes, anti-ratcheting devices, and time delays. Running the fan slower, which raises tower and water temperatures, can prevent icing in cold weather. A VFD can reverse a cooling tower fan and keep the heat in the tower, if necessary. In warm weather, fans can be run faster, providing additional cooling capacity.

[H]

Application : Screw Feeder

Screw feeders are used in various industries for the metering of material into a production process. Screw feeder design closely resembles that of a screw conveyor, but unlike a screw conveyor, a screw feeder is required to be very precise and accurate. The screw in a screw feeder is completely filled with material, compared to a screw conveyor which is typically 40-50% filled. That is part of the reason the material is accurately discharged when the feeder screw is rotating at a controlled rate.

Advantages

- Capable of accurately regulating material feed.
- Capable of detecting an overload or no material in the screw situation.
- Be able to provide the required amount of torque throughout the speed range.
- The product must be capable of continuing to operate after a momentary power loss or a fault.

Excellent speed stability and low speed torque production is possible due to Yaskawa's Flux Vector Control technology.

Both the Overtorque and the Undertorque Detection functions can sense if there is an overloaded feeder or lack of material.

Accurate and quick response control of material into the production process

Feeders can quickly restart after fault or momentary power loss.

The material feed is not interrupted during brief power loss.

Use of Torque Limit can prevent screw or gear damage due to excessive torque from foreign material in the load.

Application Details

Screw feeders can generally be classified into one of two categories: volumetric or gravimetric. Both these types of feeders are required to be precise in the amount of material that is fed into the process. A volumetric feeder accomplishes its accurate feed rate by maintaining a commanded speed, which through calibration of the feeder would deliver a specific feed rate of material into the process. The screw speed can be set linearly through analog inputs or preset with digital inputs.

Gravimetric feeders, on the other hand, have more accuracy than volumetric feeders. Gravimetric feeders operate in a closed-loop system by monitoring the weight of fed material. Gravimetric feeders may monitor the material weight and feed rate and utilize the PID functionality of the Yaskawa products. The speed of the feed screw can be precisely regulated to maintain an accurate feed rate and adjust for any feed rate variations that occur.

KOLORROL drives can monitor torque to detect an undertorque or overtorque condition. An undertorque condition for a screw feeder could be an indication that the screw is not completely filled. Failing to detect this condition could provide a false indication of material that has been fed into the process and result in a bad process batch. An overtorque condition for a screw feeder could be an indication that the screw is jammed or has seized. This could result in costly damage to the feeder screw. KOLORROL drives can be programmed to alert the operator of alarm situations or bring the feeder to a stop if required. These drives can also continue to operate through momentary power losses (< 5 ms), decreasing the chance of losing a batch of material.