YASKAWA

A World of Automation Solutions

Adjustable Frequency Drives
Load Characteristic Profiles

Variable Torque. Centrifugal pumps, fans,blowers, and compressors are good examples where torque varies as the square of the change in speed and the horsepower (work) varies as the cube of the change in speed. Fans would be called squirrel cage, vane axial, etc. Pumps/compressors would be identified as piston gear, screw, helical or impeller types.

Care must be taken to insure that the pump, fan or compressor is a centrifugal one. Certain positive displacement pumps, including piston, screw, gear and progressive cavity types, have a constant torque load profile. This is also true of positive displacement blowers and screw and piston compressors.

Constant Torque. A good example is a conveyor with a constant load at all times. This conveyor could be found on a line assembling induction motors. If the conveyor is loaded with motors each having the same weight, spaced five feet apart, and its speed is varied based upon the number of work stations open that day, the conveyor load profile is constant torque. At the end of the line, the number of motors coming off the conveyor and the tons per hour would vary directly with speed. Weight moved the distance of the conveyor, per unit of time, is the *work done*; therefore, the work done varies *directly* with speed. Work Done = HP = T x S/K ; therefore, if HP varies directly with speed, then T must be constant. Other examples of constant torque applications are screw feeders, ploughs, vibrating feeders, and positive displacement pumps/fans/compressors.

Constant Horsepower. A conveyor could also have a constant horsepower load profile, dependent upon the application. A good example would be a bottling line where containers of differing sizes, and therefore differing volumes, are delivered to a takeoff which removes the bottles at a constant *volume* rate. If the takeoff was optimized for 100 gallons/minute using gallon containers, the conveyor would have to run faster to deliver 100 gallons/minute in pint containers; large containers slow, small containers fast. Torque in this application varies *inversely* as the speed; therefore, maximum torque occurs at minimum speed with the largest container. Other examples of constant horsepower are center winders, unwinders, drilling machines and certain mixers.

Other. This category of load profile is generally a combination of constant torque/constant horsepower. A good example is a grinding wheel for shaping a piece of metal such a a crankshaft. At slow speed, hogging (heavy cutting) is done. 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 hogging is complete, a polishing (light cutting) operation is performed. A higher speed and 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. Other examples of this load profile are lathes, milling machines and certain types of surface winders.

Formulas to identify the load type:	$T = \frac{HP \times K}{N}$	$HP = \frac{T \times N}{K}$	T = Torque (Force) HP = Horsepower (Work) N = Speed (RPM) K = Constant (5250)