DOL STARTING OF MOTOR WITH FLUIDOMAT FLUID COUPLING

Generally a star - delta starter is employed for a cage motor so as to reduce value of starting current kick.

In star mode the voltage reduces to 57% of delta mode value of 100%. If motor starting current kick is 6.0 pu (600%) then the starting current kick will be 6 X .57 = 3.42 pu. However the torque generated by a motor is proportional to square of voltage. Thus the starting torque of motor becomes $.57^2$ = .333 or 33.3%. If the starting torque of motor is 1.60 pu then it will reduce to 1.6 x .333 = 0.53 pu which is $1/3^{rd}$ of value in delta mode.

With $1/3^{rd}$ the starting torque the load is going to take 3 times the time required to accelerate compared to delta mode. Since the motor coupled to load gets accelerated slowly therefore it reaches to 70% speed very slowly or in long duration of time or period. Therefore the motor current decays very slowly from 3.99 pu value. After accelerating the load and motor for 10 to 15 seconds in star mode, the motor connection is switched to delta mode. This switching causes a large kick of current which will be 1.73 times of the value of the current at that moment of switching multiplied by the transient surge. Thus if the motor speed is around 30% of synchronous speed then this kick may be as high as 5.0 pu. So if starting in star mode has reduced starting current kick from 6.0 pu to 3.42 pu, then at a later stage another kick will be experienced by the motor and the electric system to a value of 5.0 pu.

It is generally a practice to oversize the motor power particularly if star-delta starting is to be employed. This ensures that even with $1/3^{rd}$ starting torque the motor will accelerate the load to atleast 70% speed in 10-15 seconds. Oversizing the motor power means recurring loss of energy and high initial cost.

Now examine DOL starting with fluid coupling in the drive system.

- Fluid coupling will enable no load starting of motor with full voltage.
- The motor will draw starting current kick of 6.0 pu. But since motor starts on no load therefore motor reaches within 2 seconds to speed of 85% at which (speed) the efficiency and power factor are far better and the motor current decays from 6.0 pu to 3.0 pu very fast. This is a big advantage.
- Full starting torque is available to motor for own starting and peak torque (pull out torque) is available for load acceleration.
- Only one starting current kick is experienced by motor as compared to two in the star delta starting.
- Considering the acceleration time and current value the calculation of heat generated in the motor and in the supply system will show that the heating will be 5-7 times more when star - delta starting is used as compared to DOL starting and fluid coupling combination.
- Where the clients do not accept DOL starting and still use a fluid coupling then the star mode duration must be restricted to less than 2 seconds. However in such cases the motor protection relay in motor starter must be set at a higher value to accept two switching kicks of 3.99 and 5.0 pu (typically) and to accept starting current for a larger duration.

Use of star- delta mode of starting with fluid coupling is not justified technically but where electricity board is adamant then this 2 second restriction is put. Otherwise star-delta starter is not required.

Other advantages of no load starting, availability of full starting torque of motor for self acceleration, availability of motor peak torque for load acceleration, fast decay of starting current to 3.0 pu in 1-2 seconds, low stresses on motor and system, smooth acceleration of load etc are good enough to justify use of fluid coupling with DOL starting.