**Talk on " AC Drive System"**
by Ir. Chew Weng Yuen

Ir. Chew Weng Yuen is currently a committee member in the Engineering Education Technical Division (E2TD).

The Engineering Education Technical Division had co-organized a talk entitled "AC Drive System" with Engineers Australia Malaysia Chapter, and the Institution of Mechanical Engineers Malaysia Branch, on 25th October 2016, at Wisma IEM. The talk was delivered by Ir. Dr. Ling Chen Hoe who is currently the Senior General Manager and Director of Meiden Malaysia.

There were 39 participants in the talk, and Ir. Dr. Ling commenced by informing that
AC drive is a type of adjustable speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying both the motor input voltage and frequency. He mentioned that many industrial processes such as production and assembly lines operate at different speeds for different line products. The reasons for using an adjustable speed drives are process control, and energy conservation. Variable motor adjustable speed drives are also known as the inverter drive, variable speed drive (VSD), variable frequency drive (VFD), adjustable speed drive (ASD), and variable voltage variable frequency drive (VVVF).

Ir. Dr. Ling then proceeded to briefly explained the basic idea of a VFD. The process of transforming the line frequency to a variable frequency is done in two steps. It involved the rectification of the sine voltage to a DC voltage and then artificially recreate an AC voltage with the desired frequency. This is done by chopping the DC voltage into small pulses approximating an ideal sine wave. A VFD consists basically of three blocks, namely the rectifier, the DC-link, and the inverter.

The rectifier unit can be either unidirectional or bidirectional. When unidirectional, the AC drive can accelerate and run the motor by taking energy from the network whereas for the bidirectional type, the AC drive can also take the mechanical rotation energy from the motor, then process and feed it back to the electrical network.

The DC-link will store the electrical energy from the rectifier for the inverter to use. It is normally stored in high-power capacitors. The inverter will then take the electrical energy from the DC-link and supply it to the motor. The inverter uses modulation techniques to create the needed three-phase AC voltage output for the motor. The frequency can be adjusted to match the need of the process that the motor is being designed to drive. The higher the frequency of the output voltage is, the higher will be the speed of the motor, and correspondingly, the higher the output of the process concerned.

Ir. Dr. Ling mentioned that AC variable speed has been used in textile machines for a long time, especially in the textile production line of long fiber spinning facilities.

The mechanism of how motor works was next being reviewed. Simply, the motor converts electrical energy to rotating mechanical energy. The coils placement in the motor creates rotating, magnetic field in the stator. The rotating magnetic field then cuts the rotor bar and induces current in the rotor. The rotor current will create magnetic field on the rotor and the attraction of rotor to the stator will create torque and, thus, horsepower.

Ir. Dr. Ling then informed that the common algorithm for the control of a three-phase induction motor is the V/f control approach using pulse-width modulation (PWM) technique. PWM is a technique used to encode a message into a pulsing signal. A table depicting the comparison between V/f and closed loop vector control was also shown.

Ir. Dr. Ling next compared the AC with the DC drives. He informed that both drives continue to offer unique benefits and features suited for certain applications. Whilst the voltage supplied to a DC motor controls its speed, an AC drive controls the speed of an electric motor by changing the frequency of the electric supply to the motor. He also cited the advantages of both the AC and the DC drives. Generally, AC drives are low cost, require virtually no maintenance, are lighter in weight, and are better suited for high speed operation. The common applications of AC drives are found in fans, compressors, pumps, blowers, machine tools like drilling machine, lifts, and conveyor belts. On the other hand, DC drives are less complex, less expensive for most horsepower rating, and DC regenerative drives are available for applications requiring continues regeneration for overhauling loads whereby the AC drives with this capability would be more complex and expensive. However, compared to DC motors, AC motors are smaller, lighter, less complicated, more efficient, less expensive, more reliable and easier to maintain. The types of motors that AC drives control are normally operating at constant speed. Allowing the user to control the speed of motor potentially yields various benefits in terms of process control, system stress, and energy saving.

Ir. Dr. Ling then went on to show some calculations involving the determination of motor speed, motor torque, and also the design of AC drive. He also briefly informed about the transformer-less medium voltage AC drives.

Ir. Dr. Ling engaged the participants with active discussion throughout the talk. It ended with the presentation of a memento to Ir. Dr. Ling Chen Hoe by the chairman of the session.

*Ir. Dr. Ling Chen Hoe explaining the characteristics of AC drive to the participants.*