Energy efficient pneumatic-electrical power systems by recycling exhaust compressed air – Grant awarded £18,192

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Summary

Pneumatic actuators provide solutions through motion technology in a range of applications. A wide range of industries now rely on pneumatics since pneumatic actuators have distinct advantages: environmentally clean, rapid point-to-point positioning, high load-carrying capacity-to-size ratio, mechanical simplicity, low cost, and ease in maintenance. In the UK, a massive energy consumer, over 10% of the National Grid output is used to generate compressed air. Also, accounting for around 20% of electricity supplied to manufacturers/factories has been employed to generate compressed air. However, the energy efficiency of pneumatic actuator systems remains low. A report by British Fluid Power Association (BFPA) indicates that, in the UK and other European countries, an energy efficiency of between 23%-30% is achieved in working systems and another report indicated that the energy efficiency of pneumatic system is even lower than 20%.

Such low energy efficiencies are mainly due to the open-circuit structure of pneumatic actuator systems. Some efforts have been made to improve energy efficiency of pneumatic actuators such as avoiding air leakages and reuse the exhaust compressed air. It is reported that an additional air tank is connected into the downstream side of a pneumatic system, forms a closed-loop circuit of compressed air. A by-pass valve has been adopted to work with the main control valve in order to recycle a part of the downstream compressed air. Although much effort has been made, it is considered that there are no suitable mechanisms to recycle energy lost at the exhaust. Therefore, there is considerable scope for research in this subject of reusing exhaust air.

The research on improving energy efficiency of pneumatic actuator systems has been carried out for over seven years at the University of Liverpool. An early research has shown that around 3% energy could be saved by connecting a by-pass valve to partly recycle the down stream exhaust air. An optimal control strategy has been developed for servo pneumatic systems, which is based on an idea of saving energy through better controls. The study has shown that 1.5~2% compressed air can be saved with the new optimal control strategy. Apart from energy efficient control, study of pneumatic actuator structure has also been carried out at Liverpool. A set of novel energy efficient pneumatic cylinders were designed at Liverpool and the university has applied for patent protection of the new design. Dr Wang and her research team recently developed a complete dynamic model for a scroll type of air motors. They found that the energy efficiency of the motor is much higher compared with other types of air motors even the air motors are

working with a low pressure air supply. This discovery provides a possible solution for recycling exhaust air and motivated the research into using this high efficient air motor to recycle the exhaust air to generate electricity for domestic uses. Liverpool University has given a full studentship in supporting this research. This proposal is looking for a “seed corn” grant to cover the cost of setting up a test rig for evaluation.