CASE STUDY 2: PNEUMATIC SYSTEMS

This Case Study by Glen Fearnett examines the nature and role of pneumatic systems used for industrial automation purposes. It also expands upon the pneumatics theory covered in the mechanical systems chapter in this book. Glen is a technology teacher with experience in the TAFE mechanical engineering and industrial automation sector. He has also worked in the hydraulic and pneumatic industry and as an engineer for the power industry.

Pneumatic systems
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Technology, as we are all aware, has contributed greatly to our modern society. We have seen dramatic changes to the way technology is used in our homes with beneficial help with our domestic duties and a whole new world of entertainment and leisure options. We have witnessed new products arrive in the market place at prices beyond the reach of most and then watched as manufacturers and the processes they use have developed in order to make the cost of these items fall.

One of the most significant developments in modern manufacturing is automation. Automation has enabled manufacturing sectors around the world to produce the enormous quantities of products required to meet the needs of the global market place.

Automation requires a systems approach to solve problems. Generally we relate systems to the electrical or electronic devices, however pneumatic control systems are mechanical systems utilised in automated manufacturing. Pneumatics is the use of compressed air to do work. Linked closely with hydraulic (oil) systems, they are both classified as fluids and are categorised as fluid power systems. A fluid is anything that flows, including both gases and liquids. There is a far greater likelihood of fluid power systems now being controlled by electronic devices called programmable logic controls (PLC) and interfacing with various electronic sensors.

The use of pneumatic technology in industry seems limitless. With the ever-increasing demand for automation, pneumatic power touches many aspects of our lives, from the newspapers we read, to the breakfast cereal we eat, the cars we drive, the toys children play with, in fact most manufactured goods.

Advantages of pneumatic systems
1. **Availability:** Most industrial plants have a compressed air supply readily available. Air is available in unlimited quantities everywhere.
2. **Transport:** Compressed air can be transported easily through pipelines.
3. **Storable:** Because air is compressible it can be stored in receivers (tanks) for later use. This means compressors don’t need to run continuously.
4. **Cleanliness:** When properly treated, compressed air poses no pollution issues, making it ideal for use in the food industry.
5. **Explosion and fire:** There is no risk of fire or explosion.
6. **Speed:** Compressed air is an extremely fast working medium, with forces of up to 30,000 newtons, it is ideal for use in automation.

Considerations of pneumatic power
1. **Preparation:** Compressed air should be free of contaminants such as oil, water and dust. To achieve this, good filtration practices must be adhered to. The air should also be subject to pressure regulation via a pressure regulator.
2. **Exhausting air:** The noise created by exhausting air will cause significant health and safety issues. Consideration must be made to reduce this noise pollution.
3. **Cost:** Although pneumatic components are relatively low cost, the cost of producing compressed air is high. All forms of wastage (leaks, over pressure, poor design) should be avoided. Approximately 50% of all energy used in the compression of air ends up as heat.
System components

Actuators cylinders

1. **Linear actuators** are used to provide motion in a straight line. These actuators have many different designs and can be either single acting or double acting.
   - **Single acting** actuators use pneumatic energy in one direction only and then mechanical energy (usually a spring) in the other.
   - **Double acting** actuators use pneumatic energy to move in both directions.
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- **Rodless cylinders** have no external piston rod. They are constructed with an internal piston that is mechanically coupled to an external carriage. This enables long stroke movement without excessive piston rod overhang.

  Rodless cylinders can be used in tandem with other cylinders to create pick and place operations.

- **Guided cylinders** have guide rods to help support the piston rod, to prevent rotation and restrict the effect of high side loads.
2. **Rotary Actuators**, as the name suggests, provide circular motion. They are available in a variety of arcs. Typical angles of rotation are 90, 180 and 270 degrees. They are commonly used in pick and place mechanisms to move parts through a fixed angle of rotation.

3. **Motors** provide continuous circular motion and are commonly used in pneumatic power tools like drills, impact wrenches, grinders and sanders, as well as drives for mixers, agitators and conveyor drives.

4. **Grippers** are used to pick up objects. They are available in internal and external varieties each with a number of configurations. Uses include robotics, and pick and place mechanisms.
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Summary of pneumatic systems
1. Are an integrated technology
2. Are easily programmed
3. Use sensors to gain feedback
4. Regularly perform millions of cycles in their operating lives
5. Can operate in extreme environments (hot, cold, explosive and chemical)
6. Can perform linear and rotational movements
7. Can perform movement in three axes
8. Are reliable
9. Perform mundane tasks previously performed by people
10. Are clean
11. Perform dangerous tasks

Common functions
1. Pick and place robotic operation
2. Packaging machines
3. Automated conveyor systems
4. Jigs and fixtures
5. Clamping
6. Spray painting
7. Guarding
8. Presses
9. Agitating
10. Product transferring
11. Hand tools

As you can see, pneumatic systems play a major part in the operation of most modern industrial and manufacturing processes. Most of us are unaware of the uses of pneumatic systems in industry. We often see machines in operation without fully realising how they work, the engineering involved and the jobs they do. The above lists should give an indication of this. If you visit a major manufacturer you should get some insight to the extent of pneumatic automation in action.