Design of Pneumatic System Simulator when Bleed Leak occurs on ATR 72-590/600 Aircraft as Learning Support at Aviation Polytechnic Surabaya

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ABSTRACT
The aircraft has a bleed air leak detection system that functions as a leak detector on the bleed air duct. If there is a leak in the area around the duct, it will be detected, because it is already equipped with a sensing element. If there is a leak around the bleed air duct, it is characterised by reduced air pressure from the minimum standard. This will be detected by the sensing element installed on the wing, pylon and fuselage. By using Arduino nano and an air pressure sensor as a sensor used when a Bleed Leak occurs and using an indicator lamp as an indicator light when a leak occurs, so that when there is a pressure less than the specified standard, the indicator lamp will light up as an indication of a leak. The reason is because there is a system failure in bleed air leak detection, which is a logic fault, lost continuity, disconnected thermistor, elector static, short circuit, control, component dislocation, fault in the connector and corrosion.

Keywords: Bleed Air Leak detection, Sensing element, Bleed Air Duct, dan Indicator lamp.

1. INTRODUCTION

The development of air transport modes, especially aircraft, prioritises comfort and safety along with evacuation. This requires aircraft to fly faster and higher by prioritising passenger comfort and safety. The aircraft happens icing or ice clots when the aircraft is higher in the air, resulting in the temperature also becoming lower. This is the cause of ice on the aircraft structure. However, the air pressure in the cabin will also increase as a result. So that ice clots in the aircraft inlet duct, a source from the engine bleed air system is used, besides that the engine bleed air system is also used as a source of air conditioning as a coolant in the aircraft cabin.

Because of this, aircraft have several complex systems, one of which is the bleed air system, a system that provides hot and pressurised air (bleed air) which is used for several needs on the aircraft. The source of bleed air system is obtained from the Auxilary Power Unit (APU) Bleed Air System, Engine Bleed Air System, and Ground Air Connection pneumatic system..

Engine bleed air system is an aircraft system that functions to produce high pressure air that is compressed from the engine rotation. This produces high pressure that enters the system needed by the aircraft. Failure in engine bleed air can be caused by low pressure, overpressure and overheat. The use of high pressure air produced from the engine bleed air system can facilitate the work of other systems, including anti-icing, air conditioning and engine starting.

The aircraft has a leak detection system around the duct, namely Bleed Air Leak Detection. The Bleed Air Leak Detection System can detect if there is excessive heat outside the duct around the Bleed Air Leak due to a leak. To ensure fast leak sensing, around the part of the duct that has a high temperature, a Kevlar envelope is installed to collect and direct leaking water towards the sensing element.

Leaks that occur in the bleed air duct are detected by sensing elements in the form of wires on each duct installed on the aircraft, such as in the wing, engine pylon, and fuselage.

Low pressure is a condition where the air pressure value (pressure) generated from engine bleed air is below the minimum standard. During aircraft ground operation, low pressure often occurs due to damage to the high stage valve. This high stage valve functions to channel bleed water when there is low engine power and also a leak in the duct which results in a decreased air pressure value. In the duct flow generated from bleed water when flowed to the pack for anti-icing, and air conditioning needs.

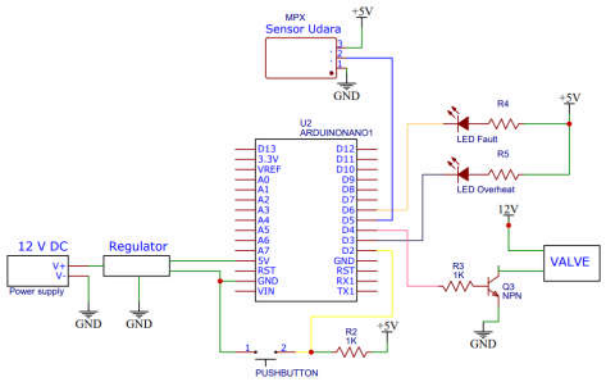
Pneumatic system Simulator when Bleed Leak happens is an object, equipment used to make it easier for cadets to understand learning in the Aircrfat System and Gas Turbine Engine courses while learning in the AMTO 147D-10 Hangar at the Surabaya Aviation Polytechnic AMTO147D-10 Hangar.

Based on these problems, the authors decided to make a simulator called: "Design of a PNEUMATIC SYSTEM SIMULATOR WHEN BLLED LEAK HAPPENS ON ATR 72-590 / 600 AIRPORT TO SUPPORT LEARNING AT THE AVIATION POLYTECHNIC OF SURABAYA".

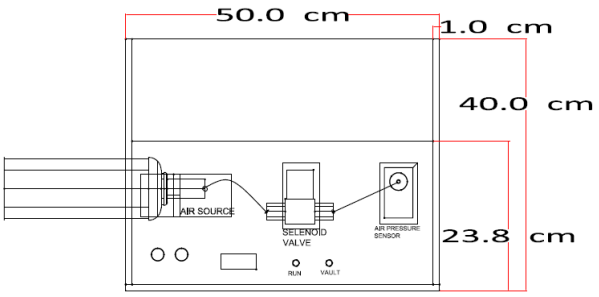
2. METHODS

With the condition of the bleed leak on the pneumatic system in the aircraft at this time the writer makes a Pneumatic system simulator design when a bleed leak occurs on this aircraft. using simple electronic objects and components that have functions and working principles resembling the original system.

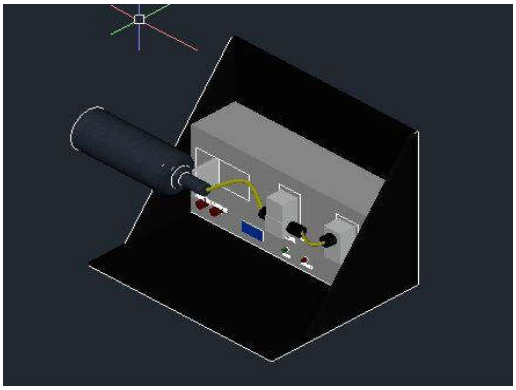
2.1 Conditions to be Designed



Wiring Diagram Image



Simulator Design Picture Front View



3D Design Picture of Simulator Front View

The following is a description of the function of the components in the design:

1. AC/DC Adapter: Serves as a converter of AC voltage into DC. To supply power to electronic components with DC voltage.
2. Heat gun: Serves as a component that simulates the engine bleed air found on the aircraft.
3. Step Down Regulator: Serves as a voltage reducer 12V to 5V
4. Arduino nano: Is the main system circuit that functions as a control of props
5. Pneumatic Speed Control: Serves to reduce air pressure in the duct flow. This is to make it appear as if there is a leak which results in reduced air pressure not in accordance with the minimum standards.
6. Solenoid Valve: Serves as a component that prevents the flow of air back to the compressor, when the bleed valve is opened
7. NPN Transistor: functions as an amplifier, switch, stabilises the voltage that gives arduino signal commands.
8. Resistor: used to limit electric current and also acts as an electric voltage divider.Indicator light: Sebagai komponen yang mensimulasikan menandakan terjadi troubleshooting.
9. Push Botton: sebagai komponen yang mensimulasikan ketika terjadi fault maka ditekan untuk mematikan atau cut off pada system tersebut
10. Component air pressure sensor that functions as a detector when there is a leak in the duct..
11. LCD I2C is a component that functions to display the value of air pressure generated by the heat gun as a compressor

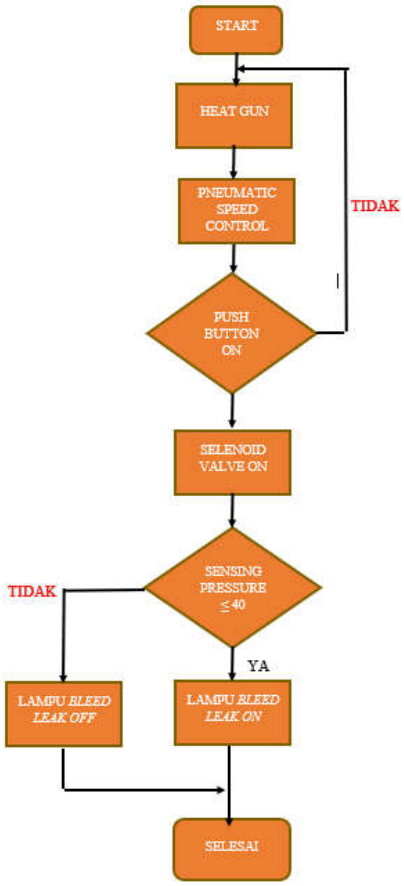


Figure Flowchart of How the Simulator Works

Prosedur penggunaan alat simulasi *pneumatic system* ketika terjadi *bleed leak* sebagai berikut:

1. Starting from the incoming power supply to provide power to the simulator tool flowed to the solenoid valve
2. Then given a step down regulator to lower the voltage from 12V to 5V to supply the push button botton, arduino nano sensor, and leak led, fault led and 12C LCD.
3. Air from the heat gun enters through the duct, then passes through the solenoid valve
4. Furthermore, the air passes through the Pneumatic Speed Control here which functions to reduce the pressure on the duct flow. This is to make it appear as if there is a leak which results in reduced air pressure not in accordance with the minimum standard.
5. When hot air passes through the solenoid valve then gives a signal to Arduino nao on pin D4. When air passes through the air pressure sensor, it gives a signal to Arduino nano via pin D5. The function of the air pressure sensor here serves to detect the amount of air pressure value if there is a leak, the pressure will drop / low not according to the minimum standard. So the arduino is given a digital signal by the selenoid valve for active conditions or not, or cut off or not.
6. Then, when trouble occurs, the arduino nano gives a digital signal pin D6 and D3 to turn on the fault led and leak led. When a bleed leak occurs, the pressure decreases from the normal pressure of ± 7000 Psi so that the indicator lamp is on on the panel.
7. When a troubleshoot occurs, press the push button botton switch and the solenoid valve will close the indicator off..

3. RESULTS AND DISCUSSION

Based on the explanation of the previous research methodology, the author will convey the results of testing the tool can work in accordance with its design.

3.1 Experiment Results

Regulator Heat Gun	Air Pressure (Psi)	Selenoid Condition Valve
8	22000	Open
7	21876	Open
6	20123	Open
5	18321	Open
4	15123	Open
3	14886	Fault
2	-2026	Close

In the first experiment, the heat gun regulator was set at the largest number 8 directly. When the push botton button is pressed for Run, the air pressure value that can be monitored on the laptop screen will come out with a value of 22000 kPsi. When the heat gun regulator is turned on a low number, the pressure value displayed on the laptop screen decreases. When the air pressure value shows 15123, the red LED fault light turns on. This as a simulation shows that there is a leak / air leak which results in reduced air pressure

3.2 *Standard Operational Procedure*

1. Check that the simulator is clean and in good condition with no damage to the components.
2. Install the adapter as the incoming power supply to provide power to the simulator tool.

3. Press the on switch on the hot gun and the run switch so that the valve is in the on position.
4. Set the air speed on the heat gun that is flowed to the selenoid valve and the mpx air pressure sensor.
5. Under normal circumstances, the indicator light is off. Air pesuure output power from sensor 0 (zero). When there is low pressure (pressure <7000 Kpa), there is a reduction in air presuure to normal conditions and indicator light on which indicates a troubleshoot.
6. When a troubleshoot occurs, press the off switch on the push botton and the solenoid valve will cut off the air flow to the air pressure sensor, it will indicator light off.
7. Disconnect the adapter as a power supply on the simulator tool.
8. Tidy up and store the simulator tool to avoid damage to the components.

NOTE: Do this carefully while the simulator is switched on. Make sure the place is clean and dry to avoid unwanted things.

3.3 Maintenance Procedure

1. Checking the simulator before and after use. The purpose of maintenance is to prevent or move the possibility of interference or damage to the simulator tool without waiting for signs of damage.
2. Periodic Maintenance
   To extend the life of the simulator tool, it is necessary to maintain the simulator tool regularly to ensure damage-free operation.
3. Overhaul Maintenance
   Each component is subjected to maintenance carried out at certain intervals..

4. CONCLUSIONS

The conclusions that can be taken from the tests performed are as follows:

1. The design of the Pneumatic System Simulator Tool when there is a Bleed Leak on the ATR 72-590/600 Aircraft as a Learning Support at the Surabaya Aviation Polytechnic is adjusted to work like the original in the form of a heat gun as an air generator such as a compressor, solenoid valve in the plane and there is an air pressure sensor inside.
2. The workings of this tool can be used as educational media, especially about Aircraft System material which is one of the courses at the Surabaya Aviation Polytechnic Aircraft Engineering department.
3. In testing the air pressure sensor, using testing media, namely air generated by a heat gun and an airtight testing ground. Some of these testing media have a level of sensitivity that can affect the air pressure value displayed on the monitor screen.

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