DESIGN OF A FLIGHT CONTROL SYSTEM RUDDER SIMULATOR ON AN ARDUINO UNO-BASED BOEING 737-900ER AIRCRAFT AS A SUPPORTING FACILITY FOR PRACTICAL ACTIVITIES AT THE SURABAYA AVIATION POLYTECHNIC

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Abstract
Pneumatic system or bleed air has the aim to provide information in performing troubleshoot techniques and maintenance procedures on engine bleed air system components. Engine bleed air system is a system that produces compressed air from engine rotation. This process can produce compressed air that enters the system needed by the aircraft, taking into account low pressure, overpressure and overheat. With overheat conditions in the pneumatic system on the current aircraft, the author designs a Pneumatic system simulator when overheating occurs on this aircraft using simple electronic objects and components that have functions and working principles resembling the original system. The incoming power supply provides 12 V power which is then flowed through a stepdown regulator to reduce the voltage to 5 V which is used to supply the LED lamp, pushbutton switch, temperature sensor, and Arduino. When the temperature sensor detects a temperature that exceeds the predetermined limit, the Arduino will provide input to the LED lamp to light up. Pneumatic system simulator tool when overheating occurs in engine bleed water does not work if there is one component not connected or incorrect installation and not as expected. In the initial stage of the experiment where this hot gun is an example of media when simulated, namely as a compressor to produce hot air. In the first experiment set at a temperature of 29°C, the overheat indicator lamp did not turn on. And at a temperature of 30°C, the overheat indicator lamp is also still not lit. At this temperature 31°C, the overheat indicator lamp and also the fault indicator lamp are lit. That indicates that the temperature has touched the maximum limit or has exceeded the maximum limit.

Keywords: Pneumatic System, Overheating, Bleed air, Indicator Lamp, Simulators.

INTRODUCTION

Pneumatic system or bleed air has the aim to provide information in performing troubleshoot techniques and maintenance procedures on engine bleed air system components. Engine bleed air system is designed to supply compressed air from the compressor to the air conditioning pack system with the aim that the aircraft can be pressurized in flight. In this engine there are two compressors that produce pressurized air, namely from stage 9 and stage 5 compressors.

The pneumatic system gets air from the engine stage 9 compressor (high pressure) in a state where low throttle settings and stage 5 compressor (low pressure). In circumstances where hight trhottle settings air is obtained from stage 5 compressor section.

Engine bleed air system is a system that produces compressed air from engine rotation. This process can produce compressed air that enters the system needed by the aircraft, taking into account low pressure, overpressure and overheat. Proper consumption of pressurized air from the engine bleed air system can facilitate the operation of other systems such as engine starting, anti-icing, and air conditioning.

Engine bleed air system is a system that flows pressurized hot air (bleed air) from the engine rotation, resulting in bleed air flowing through many components.

The development of science and technology in the world has grown rapidly, giving birth to new discoveries that can facilitate human activities, therefore cadets at the Surabaya Aviation Polytechnic are expected to be able to

keep up with the development of science and technology in the world of aviation.

Pneumatic system simulator tool when overheating occurs is an object, equipment used to make it easier for cadets to understand learning in the Gas Turbine Engine course during learning in Hangar AMTO 147D-10.

In the AMTO 147D-10 Hangar of Surabaya Aviation Polytechnic, there are various educational support facilities that support science and technology so that cadets can always know every development in the world of aviation. When cadets carry out learning in the AMTO 147D-10 Hangar to understand a theory given by the supervisor, a tool is needed that can support these learning activities.

Therefore, the author wants to make a Pneumatic Simulator system when overheating occurs in order to increase the knowledge and experience of cadets in learning Gas Turbine Engines. The purpose of making this tool design is that cadets know the gas turbine engine system that is applied to aircraft, can facilitate the understanding of cadets during practicum in the Surabaya Aviation Polytechnic Hangar, and facilitate understanding of the development of the Pneumatic system when overheating occurs on an aircraft originating from Gas Turbine Engine material.

Based on the above background, for the understanding of cadets, a tool is needed as a means and support for practicum in the AMTO 147D-10 Hangar of the Surabaya Aviation Polytechnic, so the author raises the problem in this final project with the title "DESIGN OF A PNEUMATIC SYSTEM SIMULATOR TOOL WHEN OVERHEATING HAPPENS ON ATR 72-500/600 AIR ENGINE BLEED AS A LEARNING SUPPLEMENT IN THE Aviation Polytechnic SURABAYA".

Based on the background that has been conveyed, the following problem formulation is obtained:

1. How to design a Pneumatic system simulation when overheating occurs?
2. How does the Pneumatic system simulator work when overheating occurs?

METHOD

In this research, a research methodology was carriedout as in the following flowchart:

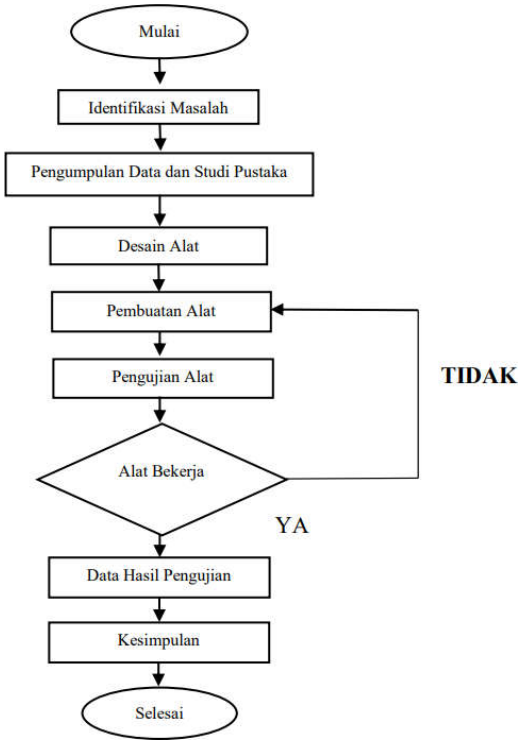

Figure 1 Flowchart of Research Design

With overheating conditions on the pneumatic system in the current aircraft, the author makes a Pneumatic system simulator design when overheating occurs on this aircraft using simple electronic objects and components that have functions and working principles resembling the original system.

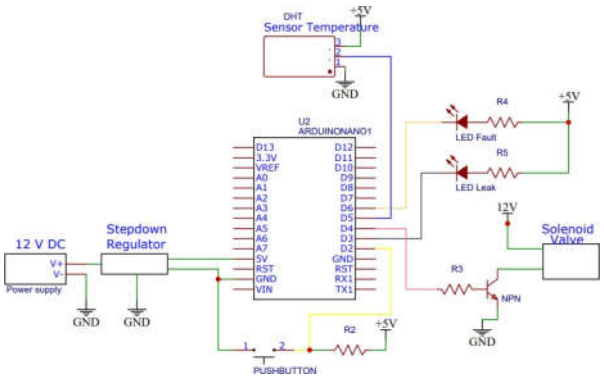

Figure 2 Wiring Diagram Design of Simulator Tool

The incoming power supply provides 12 V power which is then flowed through a stepdown regulator to reduce the voltage to 5 V which is used to supply the LED lamp, pushbutton switch, temperature sensor, and Arduino. When the temperature sensor detects a temperature that exceeds the predetermined limit, the Arduino will provide input to the LED lamp to light up.

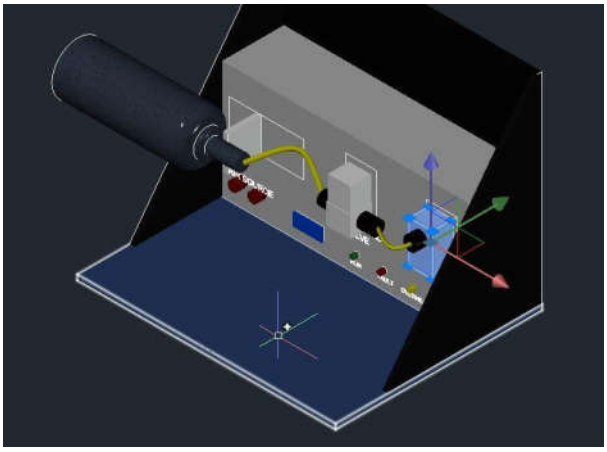

Figure 3 3D design of simulation tool

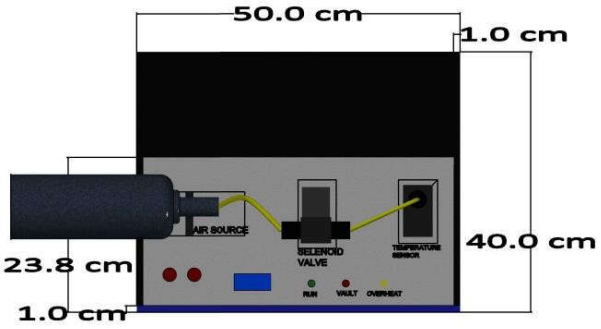

Figure 4 2D design of simulation tool

Here is the simulator design that the author designed from 3D and 2D images as follows: (1) Power, (2) Arduino uno, (3) Valve, (4) Sensor, (5) Push Button Switch, (6) LED Fault and Overheat.

In the design of this pneumatic system simulator, it is explained how the tool works. In the picture below is how the pneumatic system simulator tool works.

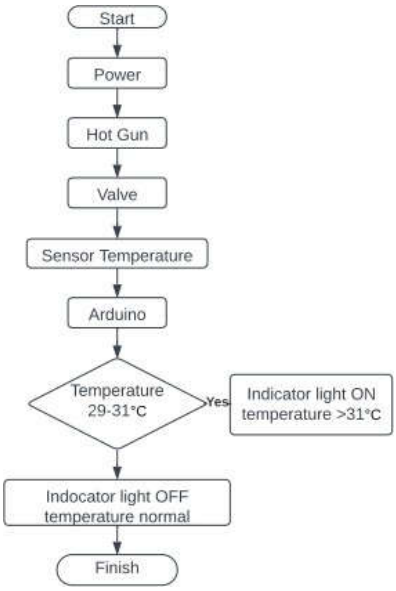

Figure 5 Flowchart How to the Tool Works

In the design of pneumatic system simulator, it start from The incoming power supply turns on the hot gun. Air from the hot gun enters the duct, passing through the temperature sensor which is controlled by Arduino Uno. At normal temperature, the power output from the sensor is 0 (zero). At that time the indicator is off. When overheat occurs, the temperature increases higher than normal temperatre (temperature>31°C). The temperature sensor provides output to the arduiono uno which has been given input or programming, and the indicator is on.

Testing the pneumatic system simulator when overheating occurs is expected to be used in accordance with the wishes of the author. It is expected that from several experiments that will be carried out on the design of this tool, it is correct as expected to work as desired.

In the data analysis technique, the author states that the Pneumatic system simulator tool when overheating occurs in the engine bleed air is declared successful if the temperature sensor, solenoid valve and all components connected to the indicator light function perfectly.The Pneumatic system simulator tool when overheating occurs in the engine bleed water is not successful if there is one component that is not connected or incorrectly installed and not as expected.

RESULT AND DISCUSSIONS

In the process of making "Design of Pneumatic System Simulator Tool When Overheating Occurs in Engine Bleed Aircraft Atr 72-500/600", the work is divided into 2 parts, namely the Hardwere and Software work processes which have their own functions and ways of working but are related to each other to form a systemon the tool.

After making the props, the next process is to try the props. The stage of trying or testing this tool is the part where you can find out whether the system is working optimally or not with the design. The purpose ofthis test is to determine the success of the simulator tool.

In the process of making a pneumatic system simulator tool when overheating occurs in the engine bleed air is divided into 5 parts which have functions and workings that are interrelated with each other to form a system in the tool. From the Hot Gun system, Selonoid Valve, GY-906 Temperature Sensor, LED Lights, and Arduino Nano. These five important components will form a system that will read the temperature sensor and will turn on the indicator light. From the process of making several stages related to

Measure the board that will be needed as a place to place the components. Where this board makes it easy to be carried anywhere easily. Install the arduino in the desired place. Where this Arduino as a core center that will receive a temperature signal from the temperature sensor and then forwarded to the indicator lamp where it

is almost reaching the specified limit, the indicator light will turn on as a warning.

Install the indicator lamp in a part that is easy to see, as a sign that the temperature has exceeded the maximum limit. Install the selenoid valve in the predetermined part, which is before the temperature sensor, as a cut off of the flowing hot air. Install the GY-906 temperature sensor in the predetermined section to get hot air.

Testing the design of this tool aims to ensure that this tool works well when tested can work as expected. If this has not been achieved or there are still obstacles and deficiencies in the simulator, then improvements to the simulator can be made as soon as possible. To get maximum data results, this test is carried out many times.

In the initial stage of the experiment where the hot gun is an example of media when simulated, namely as a compressor to produce hot air.

In the first experiment set at a temperature of 29°C, the overheat indicator lamp did not turn on. And at a temperature of 30°C, the overheat indicator lamp is also still not lit. At this temperature 31°C, the overheat indicator lamp and also the fault indicator lamp are lit. That indicates that the temperature has touched the maximum limit or has exceeded the maximum limit.

On the first try, the system starts normally and there are no problems. The run indicator lamp will light up, as a sign that the system has started running. b. Whenthe tool is on, it can be started by turning on the hot gun to flow air at the end of the temperature sensor, when the temperature reaches 29°C, the overheat indicator lamp is still not lit.

When the temperature reaches 30°C, the overheat indicator lamp is also still not lit. Because the temperature has not exceeded the predetermined limit. When the temperature has entered 31°C, the overheat indicator lamp and fault indicator lamp will light up, as a sign that the temoperature has reached the maximum limit or more than the +31°C limit.

The results of the research on testing the Pneumatic system simulator tool when overheating occurs in the engine bleed air is obtained from testing whether the pneumatic system simulator tool when overheating occurs has worked according to instructions or not, and in its operation, there are problems or not, the following data is obtained:

No.	Conditions	*Overheat Light*	*Fault Light*	*Satisfaction*	*Unsatisfaction*	Note
1	**Trial 1** Temperature 29°C	-	-	√	-	-
2	**Trial 2** Temperature 30°C	-	-	√	-	-
3	**Trial 3** Temperature 31°C	√	√	√	-	The condition of the tool is as expected

Figure 6 Device test result data

CONCLUSION

From the overall results of testing the design circuit of the pneumatic system simulator tool when overheating occurs in the engine bleed air that has been described in the previous chapter. Installation of a pneumatic system simulator tool design when overheating occurs in engine bleed air can be used as a safety support and human factor so that cadets can be more careful when practicing in the hangar. The design of the pneumatic system simulator tool when overheating occurs in the engine bleed air is more effective with an indicator lamp that makes it easier for cadets to be more responsive in safety to the trainer, so that there is no damage to the media trainer practice tool. The design of a pneumatic system simulator tool when overheating occurs in engine bleed air makes it easier for cadets to better understand the material during practicum conducted at the Surabaya Aviation Polytechnic campus, especially in AMTO 147D-10 Aircraft Engineering Study Program.

SUGGESTION

From the process of assembling the circuit and testing the tool design, there is still much that can be developed in this tool. Some of these suggestions can make it easier to develop this tool. It is expected that every time you carry out the practicum of the aircraft system to always carry out routine checks. There needs to be a tool used to accelerate the temperature rise, so that it is quickly detected by the temperature sensor. The tool can still be developed by giving its own special screen, so that if you want to see how much temperature does not need to use a laptop again.

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