Journal of Engineering, Electrical and Informatics

E-ISSN: 2809-8706
P-ISSN: 2810-0557

(Research Article)

Moog Type Syringe Pump Repair Aitecs 2016 Advance d Sryinge Pump

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Abstract. Syringe Pump is one of the medical equipment that functions to insert medicinal liquid into patients for a certain period of time regularly. The Syringe Pump cannot function as it should. The damage that occurs to the Syringe Pump is caused by an optocoupler sensor error that causes the optocoupler sensor to not be able to push the syringe and the syringe size sensor that does not detect the size of the syringe due to ineffective use and causes the syringe size sensor to not be able to detect the size of the syringe. Therefore, improvements are needed to the sensor part of this tool so that it can detect the syringe as it functions. The repair of this Syringe Pump is carried out by measuring using a multimeter through a specified measurement point, after the results of the calculation are known, followed by the replacement of the optocoupler sensor, then gluing the broken syringe size sensor with glue, and finally testing the function of the tool with the Infusion Device Analyzer (IDA) tool so that the Syringe Pump is successfully repaired and usable. The value obtained from the measurement after making repairs to TP 1 (optocoupler sensor input) was obtained an error of 0% TP 2 (optocoupler sensor output) of 0.5%. TP 3 (syringe size sensor output) of 0%. The tool used for the function test was IDA (Infusion Device Analyzer) and obtained an average of 9.50 ml/h at the 10 ml/h setting. So it was concluded that the tool was functioning well because it was still within the tolerance limit of 10%. And the result of occlusion was 4.7 ml/h which was still at the tolerance limit.

Keywords : Components ; Injection ; Repair ; Syringe Pump

1. Introduction

Hospitals are very complex systems that make it difficult to control patients. There are many cases of malpractice and along with the development of technology in the medical field, the public Demands for life safety are increasing which are related to the reputation of the hospital. This causes the need for quality improvement in the medical field. One very important and basic medical tool is a syringe. A syringe is used as a medical tool to facilitate the entry of drug fluid into the body. For patients who need extra and intensive care, a device is needed that can control the dose, volume of drug use and the flow rate of the drug to be injected. The flow rate is the amount or volume of fluid flowing measured per unit of time (Hikmah, Design of a syringe pump based on an Atmega8535 microcontroller equipped with an occlusion detector, 2013)

Syringe pumps are often heard in hospitals or clinics, where they have a function. This tool is often used in certain conditions, such as care in the ICU (Intensive Care Unit), care for patients in critical condition in the ER (Emergency Room), as well as patients undergoing surgery and so on. If freely defined, a syringe pump is a type of medical equipment or health device used to regulate the process of injecting liquid medicine into the patient's body at a certain amount and time. So, a syringe pump can be used together with other tools, namely disposable syringes or often called syringes (Nur, 2018).

The motor drive will cause the screw to advance so that it pushes the plunger (injection plunger) and the injection process begins. The pump mechanism uses a force that pushes the

Received: April 16, 2025
Revised: April 30, 2025
Accepted: May 29 , 2025
Available Online : May 31, 2025
Curr. Ver.: May 31, 2025

plunger so that the drug fluid in the tube is pushed towards the patient's blood vessels. A common problem when using a Pump syringe is occlusion (blockage) during the pump mechanism. Continuous use of a syringe pump can cause occlusion, which causes the drug fluid that enters the body to not flow consistently and creates great pressure on the syringe and fluid flow, which if left untreated will result in swelling (Hikmah, 2016)

Syringe Pump is a medical device, or health device, used to insert drug fluid into the patient's body in a certain amount and time that has been set. Syringe Pump can be used together with disposable syringes or other syringes according to the size of the Syringe Pump . This tool is widely used for patients with critical conditions such as in the ICU, ER and operating room (Aziis , 2018). The tool is a Syringe Pump brand Moog type Aitecs 2016 advanced Syringe Pump which is no longer functioning optimally as its function. Then conduct an observation of the cause of damage to the Syringe Pump . After conducting observations, it was found the cause of why the Syringe Pump brand Moog type Aitecs 2016 advanced Syringe Pump could not be used. According to the user, the damage that occurred was that the sensor could not be detected. Therefore, the medical equipment must be repaired so that it can be used and function as its function. With the background above, therefore, conduct research with the title: "Moog Brand Syringe Pump Repair Type Aitecs 2016 Advanced Syringe Pump " According to the function of the electromedic profession based on the Decree of the Minister of Health of the Republic of Indonesia (kepmeskes) number 371 / MENKES / SK / 111/2007, electromedical technicians require competence to repair medical devices both in hospitals and companies. In its implementation, electromedical technicians repair medical devices with the aim of being able to analyze and understand and be able to repair medical devices such as Syringe Pumps .

Figure 2 Moog brand Syringe Pump Tool

The image above is a Moog brand Syringe Pump type aitecs 2016 advanced Syringe Pump , before we make repairs it is a good idea to know the specifications of the tool, including:

Name : Syringe Pump
Brand : MOOG
Type/Model : Aitecs 2016 advanced Syringe Pump
Power supply : A 30W Output 12V, 2.5A
Battery : Ni-MH (7.2V x 2.5Ah)
Display : pixels 256 x 64 Illuminate
Made in : Vilnius, Lithuania
Size : 31 x 10 cm

Syringe Pump Function

Syringe Pump Function As we know from its definition, this tool helps regulate the amount, time, and dose of drug fluid injected into the patient (Sitorus , 2022) . Its use is to provide the right dose of medicine on time, according to needs, and according to the dose without injecting it repeatedly. there is also an infusion pump that is similar to a syringe pump, but is used for infusion devices.

Syringe Pump Working Principle

Syringe Pump uses a DC motor as the driving force for the syringe containing fluid or medicine to be inserted into the patient's body. This tool uses a microprocessor electronic system that functions as a controller in administering the amount of fluid to the patient's body, sensors and alarms (Siregar , 2020) . In a mechanical system with motor movement as the driving force, the Syringe Pump basically consists of various circuits, namely a comparator and a frequency signal circuit. The motor will rotate to move the syringe in response to the signal given by the motor control circuit, but the motor rotation is unstable so that changes in these changes will be detected by the rpm detector circuit (Perdana, 2021) . The signal

obtained from the rpm detector will be compared with the reference signal, where the results of the comparison will reduce motor instability. The motor will reduce its speed if the rotation is too fast or too slow, then it will increase or decrease the speed so that a stable rotation is obtained. Syringe Pump is designed to have high accuracy and easy to use. Syringe Pump is controlled by a microcontroller and is equipped with a comprehensive alarm system (Siregar , 2020) .

Repair Method

The repair method is useful to make it easier to repair the Syringe Pump Moog brand type Aitecs 2016. by determining the work steps. The work steps to be taken are as follows:

1. Provide toolbox and measuring tools to carry out the dismantling and checking process.
2. Troubleshooting the device by checking the components to see if they are functioning properly or not. Then repair or replace the components that are stated to be damaged.
3. The next step after being repaired is to perform a functional test of the tool. In this functional test, what is done is an experiment on the tool whether the repaired tool is functioning properly.
4. Compiling a report containing research on improvements to the Moog brand Syringe Pump, type Aitecs 2016.

Repair Flowchart

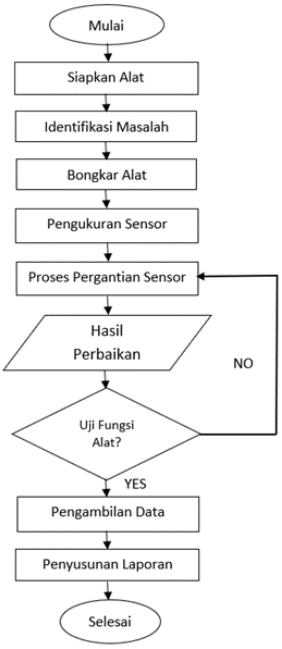

Figure 3 Moog brand Syringe Pump Tool

Damage Analysis

The testing and data analysis stage is an important step in a research because testing and data analysis serve to conclude the research results. Testing and analysis can be done through several stages as follows:

1. Conduct checks, test and analyze the final results of the repair process that has been carried out.
2. Perform a complete functional test of the tool to ensure that the repair results are correct or not and the tool can be used as it should.

   Based on the report of the Syringe Pump tool experiencing damage, then conducted an observation of the cause of damage to the Syringe Pump . Then after that conducted an observation of the cause of damage to the Syringe Pump . After conducting an observation, it was found the cause of why the Moog Syringe Pump type Aitecs 2016 could not function properly. According to the user, the damage that occurred was that the tool could not detect the Syringe/injection and when the tool was turned on there was an SP01 code. Therefore, the medical equipment must be repaired so that it can be used and

function as it should. Therefore, a temporary analysis was carried out by measuring points on the Moog Syringe Pump type Aitecs 2016 advanced Syringe Pump tool .
Checking the condition of the tool when analyzing damage to the tool, there was damage to the optocoupler sensor which is useful for reading the syringe and there is an SP01 code explained in the manual book, the damage is in the pusher sensor or what is called the optocoupler sensor to detect the movement of the syringe which experiences an error when analyzed the sensor is not properly installed on the board so that there is no voltage output from the sensor and the sensor cannot detect, and the syringe size sensor is broken because according to the user when using it is not good when installing the syringe too tightly so that it causes a break in the syringe size sensor. From the analyzed conditions, the repairs carried out were replacing the optocoupler sensor and gluing the syringe size sensor with adhesive glue. After repairs, do not forget to test the function of the tool as a sign whether the Syringe Pump tool is suitable for use or not.

Figure 4 error codes on the Syringe Pump tool

The image above shows damage to the Moog Type Aitecs 2016 Syringe Pump tool which has the code SP01 which when shown in the manual book is damage to the pusher sensor or optocoupler sensor to detect the movement of the syringe which experiences an error so that the syringe cannot be pushed and move as it should.

And there is a broken syringe size sensor section due to poor user usage, the syringe is installed too tightly which causes the syringe size sensor section to break and cannot detect the syringe size.

Table 1 Troubleshooting Syringe pump manual book

CODE	DESCRIPTION	CORRECTIVE ACTION
SP01	Push-button sensors failed	Check pusher sensor unit and replace it if necessary.
SR00	SRAM test failed after power on	Power off then on. If failure code recurs, replace Main electronic board if necessary.
SS01	Syringe size sensor readings out of range	Calibrate syringe size sensor. If the problem persists, check syringe size sensor and replace it if necessary.
SS02	Incorrect CRC of the syringe table in EEPROM	Calibrate syringe size sensor.
SS03	Incorrect CRC of the syringe table in SRAM	Power off then on. If failure code recurs, replace Main electronic board if necessary.
TR02	Internal microcontroller TRAP activated	Power off then on. If failure code recurs, replace MEB software.
TR04	Internal microcontroller TRAP activated	Power off then on. If failure code recurs, replace MEB software.

2. Results And Discussion

The following are the results of the analysis and repair of the Moog brand Syringe Pump type Aitecs 2016 which was carried out based on the manual book which recommends checking the pusher sensor when the SP01 code appears on the tool .

Replacement of Syinge size sensor and optocouler sensor components

The process of replacing the optocoupler sensor component and the Syringe size sensor is done by disassembling the Syringe Pump tool first. Then remove the two sensor components in the mainboard circuit carefully so as not to damage other components. After being removed, then repair the error Optocoupler sensor component replaced with a new and normal component. And repair the syringe size sensor by re-gluing the broken part with glue on the broken syringe size sensor part after all is replaced and repaired, reinstall the Syringe Pump as before.

Functional Test Results

The results of the function test or so-called calibration are used to reset the tool according to the provisions in the national ministry of health because if it does not comply with the provisions of the ministry of health the results of the tool are not accurate and the tool is considered unfit for use. Below are the results of the function test of the Syringe Pump tool , moog brand, type aitecs 2016 as follows

Table 2 Electrical Safety Testing

NO	Parameter	Measura ble	Tolerance	Unit
1	Voltage Supply Power	217.2	220 ± 10 %	V
2	Resistance Grounding Protective	0,000	0.2	N
3	Isolation Resistance	0.0	2	M N
4	Earth Leakage Current Normal Polarity	0.2	500	Yes

Table 3 Average Electric Current

Tool Reading	Reading Standard	Correct	Uncertainty
Ml/h	Ml/h	Ml/h	Ml/h
10	9.50	-0.50	0.42
50	46.81	-3.19	0.50
100	94.52	-5.48	1.11

Table 4 Occlusion

Reading standard	Reading max standard	Maximum Limit	Uncertainty
Psy	Psy	Psy	± Psy
4.6	4.7	45	0.42

Calibration Stamp

Below is a stamp that shows whether the MOOG brand Syringe Pump type Aitecs 2016 has passed the functional test or not.

Figure 7 Image of calibration stamp

CONCLUSION AND SUGGESTIONS

Based on the results of the research that has been conducted, the author draws the following **conclusions:**

Based on the repair process carried out, it can be concluded that the initial step involves preparing the necessary tools and materials, followed by a thorough analysis of the damage to the MOOG Type Aitecs 2016 Syringe Pump. This includes checking the circuit, power supply input and output voltages, battery voltage, and measuring the input and output voltages of the pusher sensor, size sensor, and optocoupler sensor. The analysis revealed damage to the syringe size pusher sensor and the optocoupler sensor, leading to the replacement of the faulty optocoupler component. After completing the repairs, a functional test was conducted by measuring the flow rate, and the results showed that the MOOG Type Aitecs 2016 Syringe Pump was operating properly and is now ready for use again.

Suggestion

The creation of this scientific work is not yet perfect and has several shortcomings, so the following suggestions will be provided.

1. Before carrying out repairs, it is best to carry out thorough planning, for example, by increasing the literature study on the equipment being repaired in order to better understand the tenancy of the equipment being repaired.
2. Replacement components must be in accordance with the previous components, both physically and in terms of component specifications so that the tool's performance remains good when used and ensure that component replacement is carried out carefully so as not to damage other components.

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