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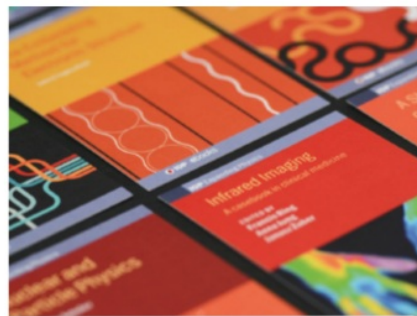
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Application of the principle of hydraulic cranes on the conductivity tester

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Abstract. This research is based on the idea that the need for an innovative experimental learning media in the study of electrolyte and non-electrolyte solutions. The innovative experimental learning media produced in this study is miniature cranes to test the electrical conductivity of electrolyte and non-electrolyte solutions. Crane equipment with hydraulic power is widely used to lift heavy loads at construction sites. The working principle of hydraulic cranes that utilizes the nature of the pressure of the liquid in the hydraulic pump according to Pascal's Law. The working principle of the hydraulic pump has been applied to design a solution of electrical conductivity test equipment. The hydraulic system of a large device has been modified using tools and materials that are easily available in everyday life. The design of the electrical conductivity test equipment is composed of a hydraulic pump made from used injection hydraulic hose and hydraulic fluid. When the hydraulic pump is given pressure, the fluid (colored liquid) will continue the pressure through the hydraulic hose to the hydraulic working cylinder, so that the crane connected to the two electrodes can move. As a current source, Power bank circuits are used with a USB (Universal Serial Bus) cable and 5 Watt LED lights for conductivity indicators. Miniature props with hydraulic working principles are expected to provide new experiences in the electrical. Miniature props with hydraulic working principles are useful as innovative, interesting and learning media fun for students.

1. Introduction

Testing the electrical conductivity of solutions is an experimental procedure that is routinely carried out in chemical learning. Through experiments, students can find differences between strong electrolytes, weak electrolytes and non-electrolytes in sample solutions that are often found in everyday life [1]. For this purpose, electrical conductivity testing equipment is used. The electrical conductivity test equipment used can be a simple electrical circuit connected with a self-made test lamp or a test equipment manufactured by a factory with a high degree of accuracy.

Several studies on the electrical conductivity tests of solutions using various media have been carried out by [2-5]. However, the learning media that have been applied are not accompanied by practical activities. In previous research has been developed tools test the electrical conductivity of the solution using a direct current electric source to turn on a lamp with a voltage of 2.5 to 3 Volts [6,7]. Generally, for chemistry learning in schools, students can create their own electrolyte test equipment in a simple way.

However, it is important to make different prototypes of electrical conductivity testing equipment by integrating basic concepts of science that are easily designed using simple materials in the environment.



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It aims to trigger creativity and innovation so that learning becomes more fun [8]. In this study an electrical conductivity test device has been created that combines a simple electrical circuit with a hydraulic crane that refers to Pascal's Law [9]. This miniature props give a new experience in the learning process that will make it more fun [10]. As a current source, Power bank circuits are used with a USB (Universal Serial Bus) cable and 5 Watt LED lights for conductivity indicators.

2. Method

Design Based Research is used to produce a prototype of a solution of electrical conductivity test equipment [11]. The research was carried out with the following steps: 1) needs analysis and study of the integration of science material that could be developed for the preparation of tool prototypes. 2) Product design, which includes the design of the flowchart and story board to determine the design of the prototype display. 3) Preparation and assembly of prototypes. 4) Validation and feasibility trials. Validation of the prototype was carried out by three chemical education validators. The feasibility trial was conducted by ten students. The instrument for validation and feasibility test consists of nine aspects, namely aspects of conformity with the objectives of learning, conformity with the material, practicality, resilience, efficiency, safety, aesthetics, completeness of kit boxes and manuals.

3. Result and discussion

Crane equipment with hydraulic power is widely used to lift heavy loads at construction sites. The working principle of hydraulic cranes that utilizes the nature of the pressure of the liquid in the hydraulic pump according to Pascal's Law. The working principle of the hydraulic pump has been applied to design a solution of electrical conductivity test equipment. The hydraulic system of a large device has been modified using tools and materials that are easily available in everyday life [6].

The design of the electrical conductivity test equipment is composed of: a hydraulic pump made from used injection hydraulic hose and hydraulic fluid. When the hydraulic pump is given pressure, the fluid (coloured liquid) will continue the pressure through the hydraulic hose to the hydraulic working cylinder, so that the crane connected to the two electrodes can move [5]. The display of solution conductivity test kits resembles the shape of a crane's heavy equipment. Crane is one of the most important equipment in construction sites because cranes have flexibility and good load performance so cranes are widely used for jobs that require the removal of large quantities of cargo or goods [12].

Making prototype tools is carried out with the following stages: 1) Preparation of tools and materials, 2) Making crane stands, 3) Making working cylinders, 4) Making neck, arms and crane bodies, 5) Making pumps and hydraulic fluids, 6) Merging working cylinders and hydraulic pumps, 7) Making tool boxes, 8) Making solution conductivity test sets, 9) As a current source, Power bank circuits are used with a USB (Universal Serial Bus) cable and 5 Watt LED lights for conductivity indicators. 10) Final assembly prototype tools. The resulting product can be seen in Figure 1.

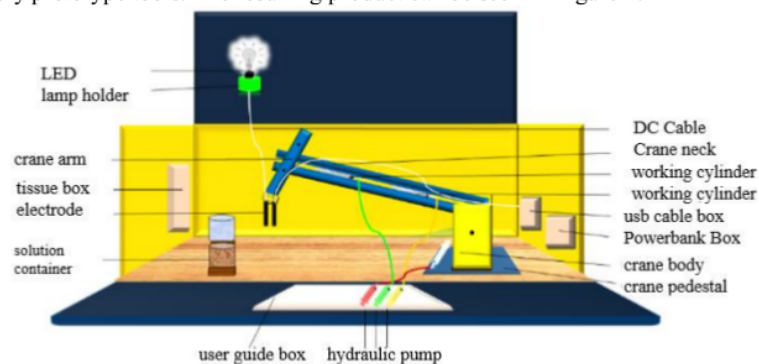


Figure 1. Design kit.

The kit components are designed with regard to safety for students by using tools and materials that are non-toxic and harmless to humans as well as their environment in accordance with the green chemistry approach. This green chemistry study covers effective concepts and approaches to prevent environmental pollution caused by toxic and hazardous chemicals processes and products, because it needs to be applied in chemistry learning in schools and in universities especially in laboratory activities [13].

Tools and materials used in kit components are not easily broken like glass, but generally use wood, plastic and cardboard. For example, in the selection of lights for the conductivity test series, the LED lamp is made of plastic so that the lamp is not easily broken and durable. In accordance with the statement Utami, et al. who stated that the basic ingredients used in making kits did not use glass material so it would not break easily and injure students [14]. The kit components are protected by boxes made of plywood. The kit box is made of plywood base material, therefore this kit box has good durability. As stated by Deti and Mulyono about plywood or commonly known as plywood, it has good durability so that making plywood shapes is not easily changed [15].

Produced learning kit media declared valid with r count of 0.79. This number shows a valid result with the feasibility interpretation quite high. The results of the feasibility study of kit learning media obtained an average value of percentage of 91.53% and supported by the assessment data worksheets with percentage averages amounting to 91.67%. Numbers obtained indicates that the solution conductivity test kit use the principle of hydraulic cranes including into the category of very decent and ready used as a learning media [16].

4. Conclusion

Based on the results of the study obtained products in the form of solution conductivity test kits using the principle of hydraulic cranes equipped with user manuals and worksheets. The solution conductivity test kit is specifically designed to resemble the shape of a moving crane with a hydraulic system based on Pascal's Law. The components of the kit use waste (used goods). From the results of the validation and feasibility test of the product kit the conductivity test of the solution using the principle of hydraulic cranes is declared valid (r count = 0.79) and is suitable for use. Based on these results it can be explained that miniature props with hydraulic working principles are worthy of being used as a medium or a tool in learning chemistry. The product can also be used for electrolysis experiments. Miniature props with hydraulic working principles has innovative characteristics with a special design resembling the shape of a crane that moves with a hydraulic system based on Pascal's Law principles so as to be able to develop active responses of students in the subject matter of electrolyte and non-electrolyte solution.

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