This paper deals with process of remanufacturing which is a process that is applied to products have expired or have been damaged, so the products can be reused with almost the same quality and balance as new products. PT UTR plant Jakarta has a new project, namely remanufacturing PT MCG’s hydraulic cylinder. To maintain customer trust, each component that is remanufacturing must be ensured of its quality by means of testing before being sent to the customer. This equipment is made based on the use of management methods that have been standardized, namely 7++ ups tools. In collecting the required data, a direct approach was taken by following the existing remanufacturing process flow, so that the tool to be made was really useful and easy to use. From the results of the research carried out, we make a special equipment of a stand test bench hydraulic cylinders so that each component of the hydraulic cylinder that was remanufacturing could be done on a test bench. With this equipment, the quality standards of remanufacturing hydraulic cylinders can be accounted for.

**ABSTRACT**

In order to support the hydraulic cylinder remanufacturing process in accordance with customer expectations, it is necessary to make tools to speed up and simplify the final checking process so that the resulting product is in line with expectations. To get optimal results, the process is carried out using a standardized management system for each improvement process in the UT group environment, namely the 7Ups++ (Manurung et al., 2018; Megel et al., 2011; PT Universal Tekno Reksajaya, 2013; Technical Training Department, 2012). In general, this method consists of 3 basic steps, analysis, solutions and results, where each step has the advantages of existing innovation methods. The three steps can be described as in Figure 1. These are frame of mine to develop every improvement in all section and or department for continuing to be sustain in the future.
1) Mapping  2) Target setting  3) Root cause  4) Idea exploration  5) Planning
6) Implementation  7) Review  8) Standardization  9) The next step

Remanufacturing is one option so that the product can still be used optimally at a relatively lower cost (Fofou et al., 2021; Liu et al., 2019; Nwankpa et al., 2021; Singh & Jain, 2019; Soeseno & Kusumastuti, 2019). Therefore, many customers choose to remanufacturing their heavy equipment components rather than buying new ones. The hydraulic cylinder is an actuator that functions to change the pressure energy possessed by the fluid being pumped from the hydraulic pump into mechanical energy that moves linearly so that it can move attachments (Szepesházi et al., 2015; Xu & Zhang, 2016). The hydraulic cylinder has oil ports holes as oil inlets and oil outlets on the head end and bottom end (Duffy et al., 2017; Ji, 2021). If one of the oil ports given pressurized oil in one of the oil ports, the oil ports function as oil inlets and the other serves as oil outlets. So alternately oil will flow in and out of and into the cylinder. So it will produce piston and piston rod move forward and backward (Hamad, 2016; Kumar & Lee, 2021; Onstott, 2017; Panjaitan, 2017; Sevagin & Mnatsakanyan, 2020; Tkáč et al., 2018; Yan, 2013; Zhang et al., 2021).

This paper deals with process of remanufacturing which is a process that is applied to products have expired or have been damaged, so the products can be reused with almost the same quality and balance as new products. The research may contribute to the development of more sustainable and cost-effective manufacturing practices by providing insights into the process of remanufacturing and its potential benefits. Additionally, the research may contribute to the development of new tools and equipment that can be used to improve the quality standards of remanufactured products.

METHOD

Actual Condition

The end of 2020, PT UTR Plant Jakarta won 30 variants of hydraulic cylinder remanufacturing business tender from a Copper Gold mining customer. All types of variants must be tested one by one to ensure the quality is as expected. Therefore, it is necessary to have a planning process, work plan and manufacturing process along with quality control so this project runs well and gives satisfaction to the customer. Figure 2, is a list of hydraulic cylinder’s components to be remanufacturing.
However, of the 30 hydraulic cylinder variants, only 18 variants can be tested on a bench, because the test bench tool does not cover all variants that have various dimensions. Figure 2, illustrates the condition of the availability of the test bench. In PT UTR plant Jakarta, the performance test process for hydraulic components is carried out on an existing hydraulic cylinder’s test bench. In general, the working principle is that the components are placed in the stand on the test bench, but only limited to components with a size that is not too large. Meanwhile, the hydraulic cylinder to be worked on starts from the small size to the longest full extend size of almost 7 meters. From observations in the field, it can be seen that in testing the hydraulic cylinder at this time there is no support for the rod, for small-sized hydraulic cylinders it is still safe and has no potential danger. However, large hydraulic cylinders have the potential to tip over even though the tube is tied with a chain. This has the potential to cause accidents to the equipment to be tested and the workers.

Design Process

Before designing the testing equipment, the requested data are as follows (table 1).

<table>
<thead>
<tr>
<th>Name</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Flow</td>
<td>20 L/minute</td>
</tr>
<tr>
<td>Pressure Gauge</td>
<td>500 kg/cm² (max)</td>
</tr>
<tr>
<td>Hydraulic Temperature</td>
<td>55°C (max)</td>
</tr>
<tr>
<td>Gauge Pressure accuracy</td>
<td>2% (MAX)</td>
</tr>
<tr>
<td>Hydraulic Filter Diameter</td>
<td>No more than 10 μm</td>
</tr>
</tbody>
</table>

By using the 7 Up ++ method, identification and root causes of existing problems are then found and solutions are found. The root of the problem is:

1) The test bench has not been able to test for large hydraulic cylinders.
2) The existing test bench is not safe for large objects.
3) From observing the existing tools there is an oil spill on the floor so that it can cause the operator to slip. To overcome these problems, it is necessary to make a test bench tool by making improvements to existing equipment. To realize this idea, discussions were held with the engineering team about the tool to be made. The design process for hydraulic mounts and frames using Autodesk Inventor Professional 2017 software. Figure 3a and b, is the design of the hydraulic cylinder holder.

![Figure 3. Exploded View Frame Stand Test Bench Hydraulic Cylinder (a); Hydraulic Cylinder Test Bench (b)](image)

With the help of Autodesk Inventor Professional 2017 software (Kumar & Lee, 2021; Zhang et al., 2021), a mild steel material is chosen which is easier to shape and has a relatively low price. With the same software, the working stress can be calculated and ensured safe. Simulations on a computer are carried out to see the feasibility of the design that has been made. This simulation uses a stress analysis feature with two outputs, namely von misses stress and safety factor, and the calculation results are still safe with the selection of mild steel material.
The procedures for this equipment are as follows:
1) Adjust the tube holder to the length of the hydraulic cylinder to be tested on the bench. Loosen the bolts then slide the tube holder.
2) Place the hydraulic cylinder on the tube holder.
3) Position the roller pin into the eye rod.
4) Tighten the bolt on the tube mount.
5) Tie the tube with a track belt for added safety.
6) Adjust the shim or wedge according to the height of the rod.
7) Attach the adapter and hose to the hydraulic cylinder.
Figure 6. Illustration of the Hydraulic Cylinder Position

Remarks:
1 Tube holder; 2 pin roller; 3 adjusted shim

The scheme for using test equipment in accordance with the standards applied by the company is as follows (figure 7):

RESULT AND DISCUSSION
After the tool is completed and implemented, there are 30 types of hydraulic cylinder variants that can be tested. Table 2 shows several hydraulic cylinders that have been tested on the equipment and were declared ok.
Meanwhile, the existing tools are only capable of testing 18 types of hydraulic cylinders. The perceived benefits of implementing a stand test bench hydraulic cylinder are viewed in terms of: safety, quality, cost, delivery, morale, and productivity.

**Safety**

With this tool, the work piece is protected from accidents such as tipping over during testing, so that the testing process can run according to plan and the work piece is safe during testing.

**Quality**

With this tool, every hydraulic cylinder that is remanufactured will be guaranteed its quality. Potential product defects are also eliminated, such as the potential for scratch and bending caused by the load from the rod, especially from the large hydraulic cylinder which does not have a support for the rod to move, extend and retract during testing.

**Cost**

By eliminating the potential for damage and accidents when the hydraulic cylinder is tested, it reduces the potential for claims from customers, especially during the warranty period. Claims result in large losses caused by repair costs that must be incurred and penalty costs due to products that do not match the order.

**Delivery**

This tool will help the delivery process on time and can even speed up the delivery of hydraulic cylinders to customers. Thus there will be no additional costs in the form of penalties due to deliveries that are not in accordance with the agreed schedule when the order is placed.
Morale

The advantage of using this tool will increase the confidence of employees that the remanufactured hydraulic cylinder is in accordance with customer expectations.

Productivity

By using this tool, productivity in hydraulic cylinder remanufacturing will increase. Test bench is not only done on hydraulic cylinder products with certain brands but also products with other brands.

Other costs that can be saved are expenses that arise when not currently used, for example a medium-sized hydraulic cylinder is not tested before being sent to the customer are as follows (table 3):

<table>
<thead>
<tr>
<th>Description of work</th>
<th>Cost (IDR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor cost for 6 days (average)</td>
<td>16,800,000</td>
</tr>
<tr>
<td>Cost of fabrication, seal kits, painting etc.</td>
<td>55,650 000</td>
</tr>
<tr>
<td>Cost of claim Delivery</td>
<td>Depend on hydraulic cylinder used</td>
</tr>
</tbody>
</table>

Every month there are usually 4 units of hydraulic cylinders of various sizes sent to customers. One year, there will be the possibility of hundreds of millions of rupiah in losses arise if no previous testing is carried out because of claim from customers.

CONCLUSION

The manufacture of the test equipment has a significant impact on the comfort and safety of its workers, the quality of the resulting product is guaranteed, allowing savings due to possible claims from customers, and the company's image has increased.

REFERENCE


