Redesign Leak Test Machine For Part Cover Comp Head

Sumiyanto[1], Harwan Achyadi[2]
[1] Institut Sains dan Teknologi Nasional, Jakarta, Indonesia, sumiyanto@istn.ac.id
[2] Institut Sains dan Teknologi Nasional, Jakarta, Indonesia

Corresponding Author: sumiyanto@istn.ac.id

Abstract: One of the aluminum casting component manufacturing companies produces Cover Comp Head parts that will be used on two-wheeled motorized vehicles. The customer provides that the parts produced must not leak at a pressure of 1 bar. The production demand from the customer is very high, so a redesign is needed in the form of a design for the leak tester in order to get an update on the leak test machine or the leak tester specifically for the main components of the leak tester, which are very directly related to the function of the leak tester. The method used in this redesign is the VDI 2221 method. Based on the results of the redesign carried out, it was found that the redesign concept of the comp head and tube hole compactors is more efficient in terms of dimensions and cost. So that it can provide direct benefits to the company.

Keyword: Leak Test Machine, VDI 2221, Efisien.

INTRODUCTION

Part cover comp head is one of the automotive components for two-wheeled vehicles. Function Head Cover Comp is the automotive component that serves as a cover comp head in order to prevent the oil (fluid) does not come out or spills out when the machine is used. Therefore, comp head cover is not allowed to leak, because it would interfere with the performance of the machine caused by wear part components. Because, the oil serves as a lubricant components on the machine. Another function is as a protective component that is in it, to avoid collisions.

In the actual conditions in the production area, the demand for the production of parts Cover Comp Head is very high, resulting in the production area there are four (4) leak test machine, by which time the use of Leak Test Machine in the area of production is very high, resulting in major components on Leak Test Machine frequent replacement. So, redesign especially those on the main components in the engine leak testing is needed, in order to obtain the concept of redesign the main components in a more efficient and cost dimensions. The concept of redesign obtained, is expected to provide significant benefits for the company.

LITERATURE REVIEW

Leak Test

Leak test is one of a Non-destructive testing which is related to the release of substances that flow from a place of high pressure to lower pressure chamber. Leakage is considered as a defect in a product, so that the leakage has a huge impact on safety and also on the performance of the product.

Leak Test Machine

Leak Test Machine is a tool that serves to check leakages space on a product. One is to check on automotive components that have a function as a place where the flow of a fluid or a pressurized fluid.

Leak test machine consists of several parts that support each other so that formation of a system that can process, and operates in accordance with the purpose of leak test machine, for detecting leaks in a product space.

The main components in the leak test machine is:

1. Compressing Hole Cover Comp Head

    Compressing holes Cover Comp Head serves as a hole for the air compressor and the pressure does not come out of the head through the hole Cover Comp Head current leakage detection process takes place.

2. Compressing pipe hole

    Compressing pipe hole serves as a pipe hole to allow air compressors and pressure does not come out of the head through a hole in the pipe comp head time leak detection process takes place.

3. Clamping

    Clamping useful for comp head does not move during the process of leak detection. Clamping the leak test machine is designed to press the upper part.

4. Leak Detector

    Leak Detector is a detector that serves to check for leaks in Cover CompHead.

Design Method VDI 2221

The design is the initial activity of the business to realize a product that needs very necessary or required and have a purpose tertentu.Pahl and Beitz in his book; Engineering Design: A Systematic Approach To The Design Of Technical System and Product propose a way or method of designing a product, which is known by the method VDI 2221 (VDI = VereinDeutscherIngeniure / Association of German Engineers).

A feature of the design method using the VDI 2221 method lies in the conceptual design phase, namely the presence of steps to create a structure that functions to identify elements of the system compiler techniques to be designed.

The aim is to facilitate the designer to formulate and direct the various variants of the existing design as in the method of existing ideas efficiently and systematically arranged.

VDI 2221 method consists of four phases. The fourth phase is:

1. Clarification of the Task
2. Conceptual Design
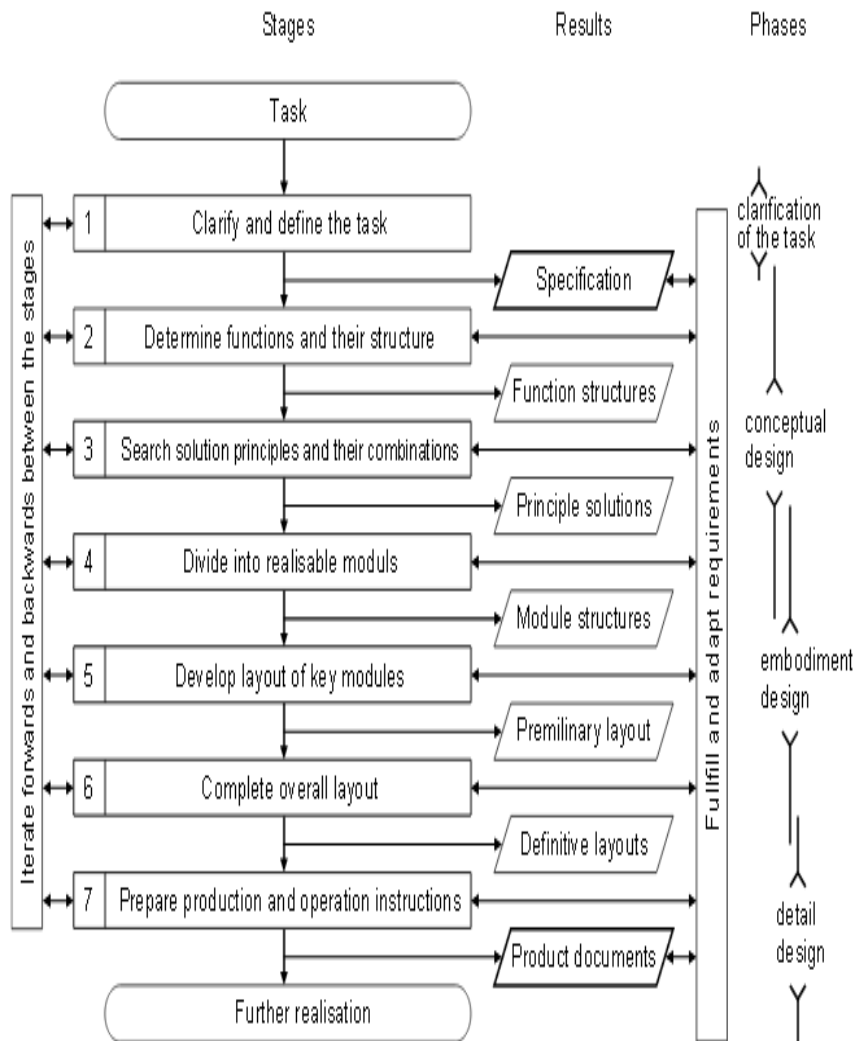3. Embodiment Design
4. Detail Design

Figure 1. Structured Procedure in the product development guideline VDI 2221

The first phase is the phase where does the formulation and list of requirements that are tailored to the will of consumers and designers, which is expected to be fulfilled by the end solution. Terms - conditions to be met in the design is distinguished as a demand or as desired.

Conceptual Design

Once the specification is obtained, steps are separation of data and formulation. The purpose of the separation of data and the formulation is to determine how the specifications are an important part and are generally accepted.

1. Embodiment Design

   Designing a form begins with the concept of engineering products, then using technical and economic criteria, the design was developed by outlining the structure of the function into the module structure to obtain elements of structure builder function that allows the start of the design can be more detailed.

2. Detail Design

   The fourth phase is a phase of the design process in the form of an image that has been formed products. The products are designed to be portrayed detail, so that the product manufacturing process can be easily understood or comprehended by the product manufacturer.

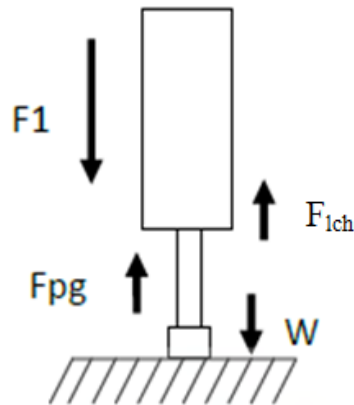**Forces on the cylinder compressing hole of Comp Head and Clamping**

Figure 2. The Force On Cylinder 1

Force on cylinder 1 can be calculated by :

$\sum$ Fx $= 0$

$\sum$ Fy $= 0$

$F1 - F_{lch} + W - F_{pg}$ $= 0$

$F1$ $= F_{lch} + F_{pg} - W$

Where;

F1   = Force on cylinder 1

F_{lch} = Air Force from hole of Comp Head

W   = Force caused by heavy tool

F_{pg} = Spring Force on clamping

Forces on the cylinder compressing hole of tube
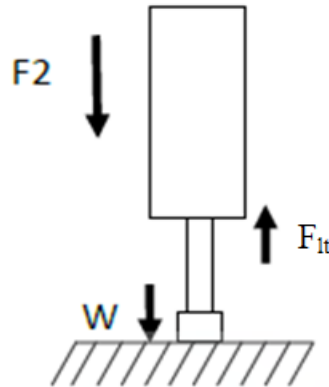
Figure 3 The Force On Cylinder 2

Force on cylinder 2 can be calculated by:

$\sum$ Fx $= 0$

$\sum$ Fy $= 0$

$F1 - F_{lt} + W$ $= 0$

$F2$ $= F_{lt} - W$

Where;

F2   = Force on cylinder2

F_{lt} = Air Force from hole of tube

W   = Force caused by heavy tool

Silinder Pneumatik

Pneumatic cylinder or actuator is a mechanical device that uses the power of compressed air (compressed air) to produce a force in a movement back - back piston in a linear manner (movement out - sign). Pneumatic cylinder is a tool or device that is often encountered in engineering - industrial machinery, be it in the automotive industry, packaging industry, electronics, and a wide range of industries and institutions - other agencies. Pneumatic cylinders used to clamp objects, push mower, a pressure pressing machine, vibration dampers, door sorting, and so forth. Pneumatic cylinders may indeed have a lot of utility functions, but the basic function of the cylinder had not been changed, where they function to convert the potential energy of air pressure or air into motion or kinetic energy.

To calculate how large diameter pneumatic cylinders are used, by the way:

$$A = \frac{F+R}{p}$$

Where:

F = Force

R = Friction = ± 3% . F

p = Working Pressure for Pneumatic

Pneumatic Pressure average is = 7 bar = 0,7 N/mm^2

METHODS

Spesification Leak Test Machine Existing Condition

NO	MAIN COMPONENT	SUB COMPONENT	DIMENTION
1	Compressing Hole Cover Comp Head	Uretan Head Head Plug	p = 37 mm, Ø = 22 mm p = 72 mm, Ø = 22 mm
2	Compressing Pipe Hole	Uretan Adaptor Adaptor	p = 18 mm, Ø = 17 mm p= 62,5mm Ø = 25 mm
3	Clamping	Head Bolt Spring Bolt Press	p = 15 mm, Ø = 25 mm p = 40 mm, Ø = 19 mm p= 100mm, Ø = 12 mm
4	Leak Detektor		

Spesification

D/W	REQUIREMENTS	INFORMATION
D	**GEOMETRI** Dimention of Tool PxLxT : 600mmx700mmx1500mm	Adjusting the space provided
W W D W	**ERGONOMI** a) Not cause operator fatique b) Machine looks nice c) Easy use d) Easy to be move	Produktifitas Estetika Produktifitas Fleksiblelitas
D W D	**MATERIAL** a) Strong and durable material b) Easily obtainable materials c) Efficient use of materials	*Life Time* *Lead time* Cost
D	**FORCE ANDMOMENT** Force and Moment use efficient	
D	**PREVENTIVE** Easy to be preventive	Fast preventive
D D D	**QUALITY CONTROL** a) Can detect leak on pressure 1 bar b) Not cause part damage/reject c) Not add leak on part	

Abstraction I

D/W	REQUIREMENTS	INFORMATION
	GEOMETRI	
D	Dimention of Tool PxLxT : 600mmx700mmx1500mm	Adjusting the space provided
	ERGONOMI	
D	Easy use	Produktifitas
	MATERIAL	
D	Strong and durable material	*Life Time*
D	Efficient use of materials	Cost
	FORCE ANDMOMENT	
D	Force and Moment use efficient	
	PREVENTIVE	
D	Easy to be preventive	Fast preventive
	QUALITY CONTROL	
D	d) Can detect leak on pressure 1 bar	
D	e) Not cause part damage/reject	
D	f) Not add leak on part	

Abstraction II

Transforming the quantitative data into qualitative which concluded the desired device is as follows:

1) The size does not exceed 1500mm 600mmx 700mmx
2) Tool easy to use by Operator
3) The material used is strong and durable
4) The material used is designed as efficiently as possible
5) Components Maintenance is easy and fast
6) Tool can detect leaks with a pressure of 1 bar

Abstraction III

The results of leak testing machine abstraction tool that will be created to detect leaks with a pressure of 1 bar, with material components used must be strong and durable as well as its use as efficiently as possible. The tool has a size not exceeding 600 mm x 700 mm x 1500 mm, and can be used easily by the operator.

Function Structure

- Overall Function

- Function in terms of *Clamping Unit*

- Function in terms of Compressing Hole Cover Comp Head
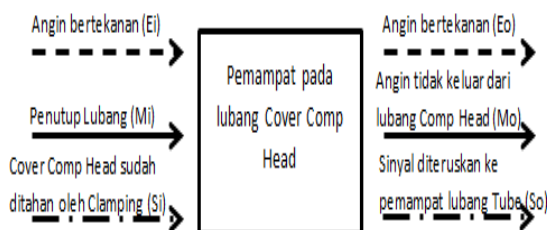
- Function in terms ofCompressing Pipe Hole
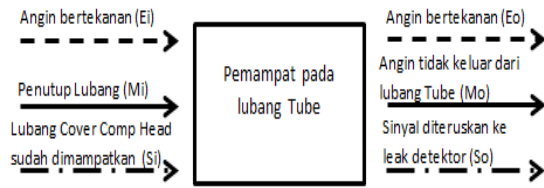
- Function in terms of*leak detector*

Princple Solution Sub Function

1. Clamping
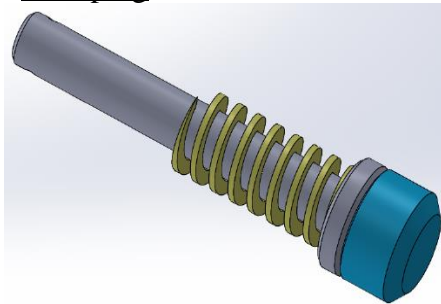
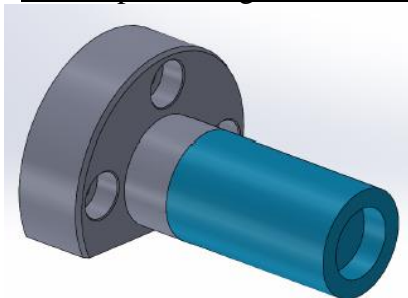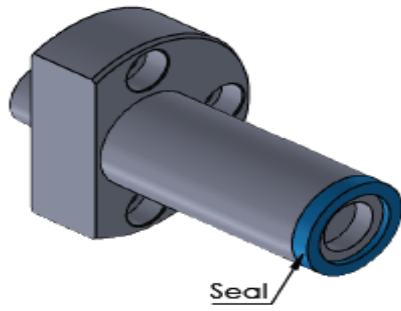   Option 1 – Silinder Universal Clamp

   Option 2 – Silinder Indicidual Clamp

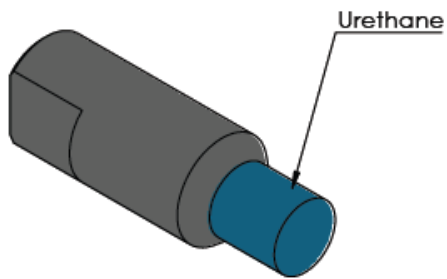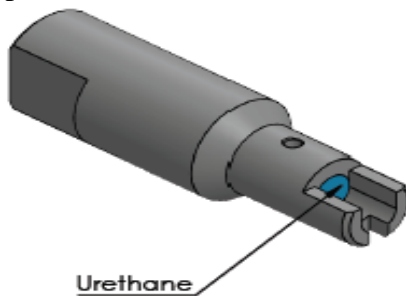2. PemampatLubang Cover Comp Head

   Option 1

Option 2

3. Pemampat lubang pipa

Option 1

Option 2

4. Leak Detektor

Option 1-Diferensial Pressure Machine

Option 2 – Water Dunk

Variations Selection Leak Test Machine

TEKNIK MESIN ISTN						VARIATION TABLE OF ELECTION VARIANTS FOR LEAK TEST MACHINE	
PRINCIPLE SOLUTIONS VARIANTS	Kriteria Pemilihan + = Yes - = No ? = Less Information ! = Check spesification					Marks of Variants Solution + = Solutions sought - = Clear the Solutions ? = Collect Information ! = Look Spesification	
	Match with overall function						
		Match with Spesification					
			On range of Cost production				
				Knowledge Of Concept is good			
					Match with Designer Wish		
						Answer a Safety requirement	

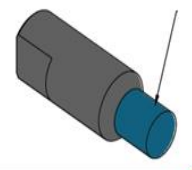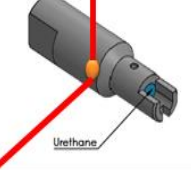|	A	B	C	D	E	F	DESCRIPTION	DECISION
CL1	+	+	+	+	+	+		+
CL2	-	+	+	+	+	+		-
PLCH1	+	+	+	+	+	+		+
PLCH2	+	+	+	+	+	+		+
PLT1	+	+	+	+	+	+		+
PLT2	+	+	+	+	+	+		+
LD1	+	+	+	+	+	+		+
LD2	+	+	+	+	-	+		-
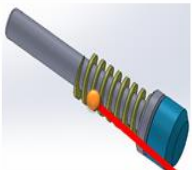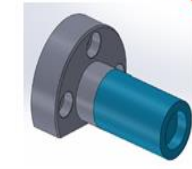
INFORMATION
CL   = CLAMPING
PLCH   = COMPRESSING OF COMP HEAD HOLE
PLT   = COMPRESSING OF PIPE HOLE
LD   = LEAK DETECTOR

Variant 1 Principle Solution

NO	KOMPONEN	OPSI 1	OPSI 2
1	CLAMPING		
2	PEMAMPAT LUBANG COMP HEAD		Seal
3	PEMAMPAT LUBANG TUBE		Urethane
4	LEAK DETEKTOR		

Variant 1 Principle Solution

Evaluation Variants of the Concept

No	Deckription	Wi	Parameter	Variant 1		Variant 2	
				Vi	Wvi	Vi	Wvi
1	Easy for use	0,2	Cycle Time	7	1,4	7	1,4
2	Easy for preventive	0,2	Easy for change tool	7	1,4	8	1,6
3	Cheap	0,15	Cost	7	1,05	8	1,2
4	Quality of product	0,2	Not makes part reject	8	1,6	8	1,6
5	Decision Making	0,2	Easy for look a result	8	1,6	8	1,6
6	Visual of tool	0,05	Tool looks nice	7	0,35	7	0,35
	TOTAL	1		44	7,4	46	7,75
	RANK			II		I	
	DECISION			NO		OK	

Calculation Of Force

1. Forces on the cylinder compressing hole of Comp Head and Clamping
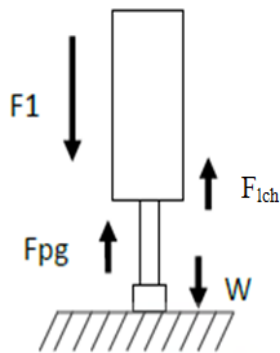
The Force On cylinder 1

Force on cylinder 1 can be calculate by :
$$\sum Fx = 0$$

$\sum Fy = 0$

$F1 - F_{lch1} - F_{lch2} + W - F_{pg1} - F_{pg2} = 0$

$F1 = F_{lch1} + F_{lch2} + F_{pg1} + F_{pg2} - W$

Dimana;

F1 = Force on cylinder 1

F_{lch1} = Air Force from hole of Comp Head 1

F_{lch2} = Air Force from hole of Comp Head2

W = Force caused by heavy tool

F_{pg1} = Spring Force on clamping1

F_{pg2} = Spring Force on clamping2

1) Air Force from hole of Comp Head 1(Flch1)

Flch1 = Fair x A

Faaair = Pressure in Comp Head

= 0,1 (N/mm^2)

A = Large area of hole Comp Head

= πr^2

= π x 14^2

= 615,752 mm^2

Flch1 = Fair x A

= 0,1 x 615,752

= 61,575 N

2) Air Force from hole of Comp Head(Flch2)

Flch = Fair x A

Fair = Pressure in Comp Head

= 0,1 (N/mm^2)

A = Large area of hole Comp Head

= πr^2

= π x 14^2

= 615,752 mm^2

Flch2 = Fair x A

= 0,1 x 615,752

= 61,575 N

3) Force caused by heavy tool(W)

Heavy tools or heavy equipment obtained from direct calculation of the tool or equipment. Calculations obtained is 4 kg, so

W = m x g

m = mass of tool

= 4 (kg)

g = gravitation

= 9,81 (m/s^2)

Jadi,

W = m x g

= 4 (kg) x 9,81 (m/s^2)

= 39,24 N

4) Spring Force 1(Fpg1)

Fpg = k . x

Spring long first (Hf) = 40 mm

Spring long attached (Hs)   = 38 mm
Core diameter spring (D)   =15,75mm
Diameter spring (d)   = 3,25 mm
The Numbers of windings (N) = 8
Shear Modulus (G)   =80.000 (N/mm^2)
So,
n   = N – 1,5
     = 8 – 1,5
     = 6,5

Spring Constants (k) $= \dfrac{G \cdot d^4}{8 \cdot n \cdot D^3}$

$$= \frac{80000 \cdot (3,25)^4}{8 \cdot 6,5 \cdot (15,75)^3}$$

$$= 43,932 \text{N/mm}$$

Spring Force 1 (Fpg1)   = k . (Hf –Hs)
     = 43,932 .(40 – 38)
     = 87,864 N

Spring Force 2 (Fpg2) = k . (Hf –Hs)
     = 43,932 . (40 – 38)
     = 87,864 N

So, The force on cylinder 1is A = F1
F1 $= F_{lch1} + F_{lch2} + F_{pg1} + F_{pg2} - W$
     = 61,575 N+61,575 N + 87,864 N + 87,864 N – 39,24 N
     = 259,638 N
R   = 3 % x 259,638 N
     = 7,789 N
So, the cylinder size required is

A $= \dfrac{F+R}{P}$

$\dfrac{\pi d^2}{4}$ $= \dfrac{F+R}{P}$

$0.785\, d^2$ $= \dfrac{F+R}{P}$

$0,785\, d^2$ $= \dfrac{259,638+7,789}{0,7}$

d^2 $= \dfrac{267,427}{0,785}$

d $= \sqrt{340.671}$

d = 18,457 mm≈ 20 mm (base on the size of the market)

So, based on the calculation of the cylinder diameter is required is a minimum diameter of 20 mm.

2. Force on The Cylinder Compressing pipe hole
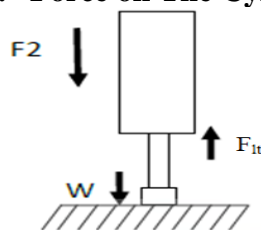
Force on cylinder 2

Force on cylinder 2 can be calculate by:

$\sum Fx$ = 0
$\sum Fy$ = 0
$F2 - F_{lt} + W$ = 0
$F2$ = Flt – W

Dimana;

$F2$ = Force on cylinder 2
F_{lt} = Air Force from pipe hole
W = Force cause by heavy tool

1) Air force from pipe hole (Flt)

Flt = Fair x A
Fair = Pressure in Comp Head
= 0,1 (N/mm^2)
A = Large area of pipe hole
= πr^2
= π x 7^2
= 153,938 mm^2
Flt = Fair x A
= 0,1 x 153,938
= 15,394 N

2) Force cause by heavy tool (W)

Heavy tools or heavy equipment obtained from direct calculation of the tool or equipment. Calculations obtained is 0,5 kg, so

W = m x g
m = mass of tool
= 0,5 (kg)
g = gravitation
= 9,81 (m/s^2)

So,

W = m x g
= 0,5 (kg) x 9,81 (m/s^2)
= 4,905 N

So, the force ono cylinder 2 is A = F2

F2 = F_{lt} – W
= 15,394N – 4,905 N
= 10,489 N
R = 3% X 10,489 N
= 0,315

So, the cylinder size required is

$A = \dfrac{F+R}{P}$

$\dfrac{\pi d^2}{4} = \dfrac{F+R}{P}$

$0.785\, d^2 = \dfrac{F+R}{P}$

$0,785\, d^2 = \dfrac{10,489+0,315}{0,7}$
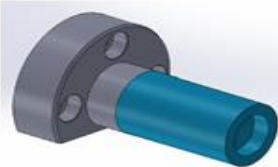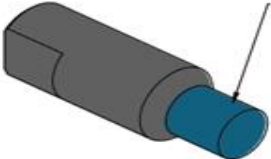
$d^2 = \dfrac{15.434}{0,785}$

$d = \sqrt{19.661}$

d = 4,434 mm$\approx$ 10 mm (base on the size of the market)

So, based on the calculation of the cylinder diameter is required is a minimum diameter of 10 mm

RESULT AND DISCUSSION
Concept of Existing Conditon

| NO	KOMPONEN	GAMBAR	KETERANGAN
4 KONDISI AWAL
1	CLAMPING		PNEUMATIC SYSTEM
2	PEMAMPAT LUBANG COMP HEAD		SEBAGIAN BESAR MATERIAL YANG DIGUNAKAN ADALAH URETAN
3	PEMAMPAT LUBANG TUBE		SEBAGIAN BESAR MATERIAL YANG DIGUNAKAN ADALAH URETAN
4	LEAK DETEKTOR		DIFFERENSIAL PRESSURE

Redesign Concept

| NO	KOMPONEN	GAMBAR	KETERANGAN
4 KONSEP RANCANGAN ULANG
1	CLAMPING		PNEUMATIC SYSTEM
2	PEMAMPAT LUBANG COMP HEAD	Seal	MATERIAL URETAN HANYA DIGUNAKAN SEBAGIAN KECIL PADA KOMPONEN
3	PEMAMPAT LUBANG TUBE	Urethane	MATERIAL URETAN HANYA DIGUNAKAN SEBAGIAN KECIL PADA KOMPONEN. TERDAPAT PENAHAN TUBE AGAR TIDAK BENGKOK.
4	LEAK DETEKTOR		DIFFERENSIAL PRESSURE

Comparative Analys Of the Concept

- ### Compressing Hole Comp Head

Uretan Pemampat Lubang Comp Head	Kondisi Awal	Rancangan Ulang
	p = 37mm, Ø = 22mm	p = 3,5mm , Ø = 22mm
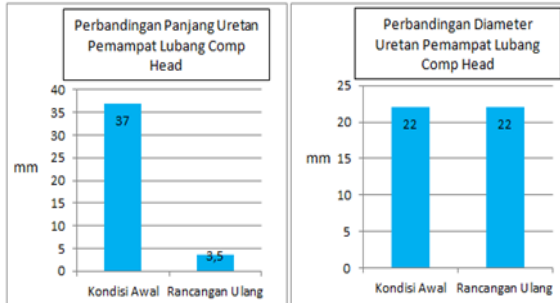
- ### Compressing Pipe Hole

Uretan Pemampat Lubang Tube	Kondisi Awal	Rancangan Ulang
	p = 18mm, Ø = 17mm	p = 4mm , Ø = 9mm
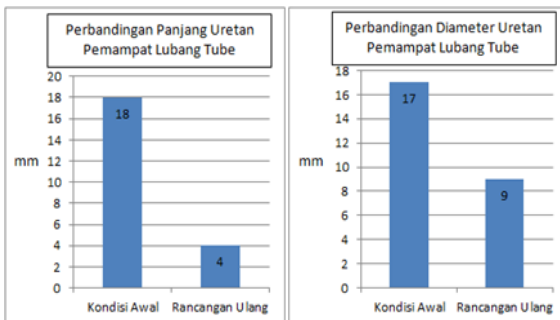
- ### Silinder Pneumatik
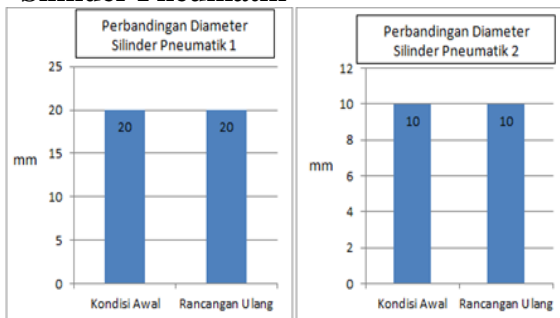
CONCLUSION

1. With repeated Compressing holes designed Comp Head on leakage testing machine was found to affect the reliability of leak testing machines. In addition, the concept of the redesign can make efficient use of on-Compressing holes Urethane Comp Head. Urethane long experience an efficiency of 90.5%.
2. With repeated designed Compressing Tube hole in the engine leak testers found to affect the reduction in reject parts caused by the bendingatau bent tube. In addition to the redesign of the concept can make efficient use of on-Compressing holes Urethane Tube. Urethane long experience an efficiency of 77.7%, while Diameter Urethane experienced an efficiency of 47%.

3. There is no difference between the size of the diameter of Pneumatic Cylinder Pneumatic Cylinder Diameter 1 and 2 in the initial conditions to the size Diameter Pneumatic Cylinder Pneumatic Cylinder Diameter 1 and 2 on the redesign.

REFERENCES

G. Pahl, W. Beitz, J. Feldhusen and K.H. Grote. "Engineering Design: A Systematic Approach, Third Edition". London: Springer Verlag, 2007

Sularso, dan Kiyokatsu Suga. "Dasar Perencanaan Dan Pemilihan Elemen Mesin". Jakarta: Pradnya Paramita, 2013.

Croser, P, dan Ebel, F. "Pneumatics Basic Level. Festo Didactic". Denkendorf: GmbH & Co, 2002.

Khurmi RS Gupta, JK. "Text Book of Machine Design".New Delhi: Eurasia Publising House, ltd Ram Nagar, 2005.

Sato, G. Takeshi, dan Hartanto, Sugiarto. "Menggambar mesin menurut standar ISO". Jakarta: PT. Pradnya Paramita, 2010.

Prof. Dr. Ir. Dahmir Dahlan M.Sc. "Elemen Mesin". Jakarta: Citra Harta Prima, 2012.

Sigit, Puradwi, Deddy, Joko, dan Ismu. "Pengembangan Teknik Uji Kebocoran dengan Detektor Gas Helium". Februari 2003. Diambil dari: http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/44/011/44011601.pdf

http://www.leaktesting.co.uk/

http://imammulyono002.blogspot.co.id/2013/06/perencanaan-pneumatic.html

http://www.cosmo-k.co.jp/english/leak-test/leak-technology/