Functional and Conceptual Design
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Lecture 38
Laboratory Exercise 11

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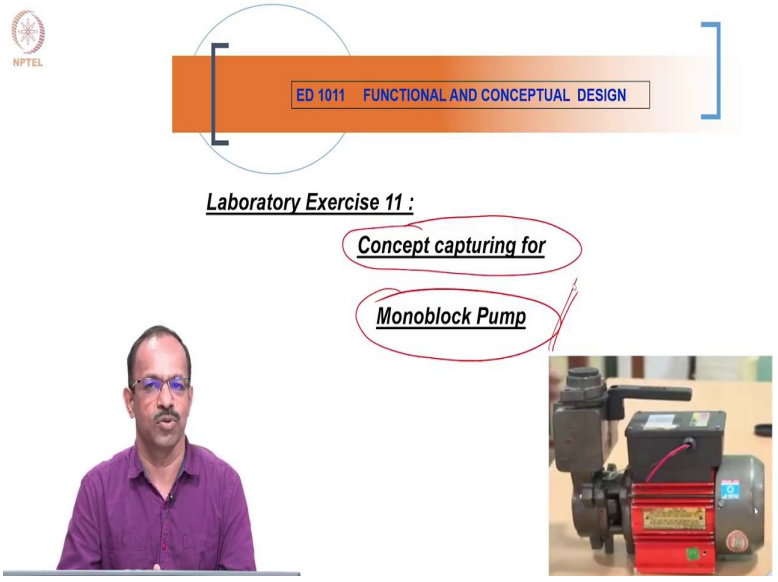

Hello everyone! Welcome to the last laboratory session on product dissection. So we will not be having any more product dissection exercises. This is going to be the last product. So this is the 10th product that we are doing. So far we have done many products and this product is Mono-block Pump. Pump, most of you are familiar with the pumps basically to pump water or I mean liquid or solid we can use semi-solid we can use pumps. Basically it will take the input from a lower head and then deliver it at a higher head that is basically a pump.

So, this exercise we are doing in order to do something called the concept capturing. Okay, actually you have been doing this concept capturing in all the exercises. Knowingly or unknowingly you are looking at how a particular product is providing a function. So that the physical form of that product actually is a concept and provided by the designer. So we will look into more details because now you know what is a concept, what is a, how a concept is developed and what are the ways in which you can actually have concept variants.

So, here in this exercise, what we will do is we will look into the product and then identify the parts and assemblies and then see what particular concept is employed by the designer in order to achieve a function, so that is what actually we will be looking. Earlier we were

looking at what part is providing a function, now we look at okay what is the concept that he is employing. Suppose there is a transmission, so whether the transmission is through a direct contact or through a belt or through shaft or some other methods is employing so, that is basically a concept.

So, this exercise will help you to know how to capture the concepts from a product or any product you would see and you would open it up you will see that some specific concept designer has employed, so what are these concepts and how these concepts are actually used in achieving particular functions can be understood through this exercise. That is the purpose of this exercise.

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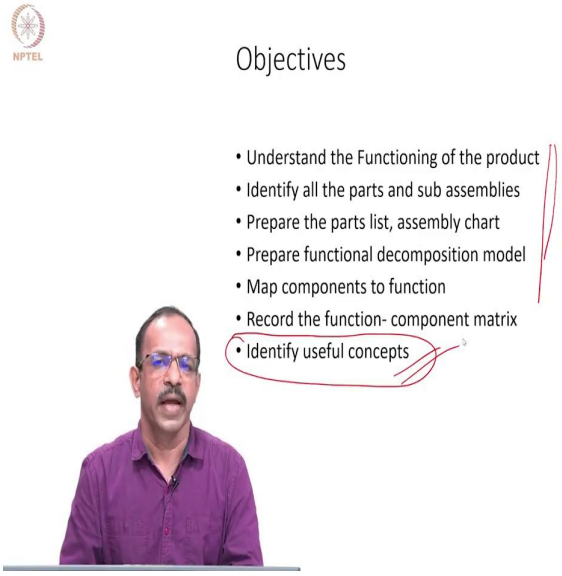

So, the objective almost remains same but, here you identify the useful concepts employed by the designer and then see how this concept or what kind of concept variants are existing for the same application. The designer has done some used a particular concept but then, through the previous exercises and then your exposure to the products now, you know that that can actually be done in a different way also.

So what is the alternate concept that you can employ that also can be discussed in the report. So, identify the useful concept that he has employed in this particular product and then see what kind of variations are possible in order to develop similar product so that is also an objective of this exercise.

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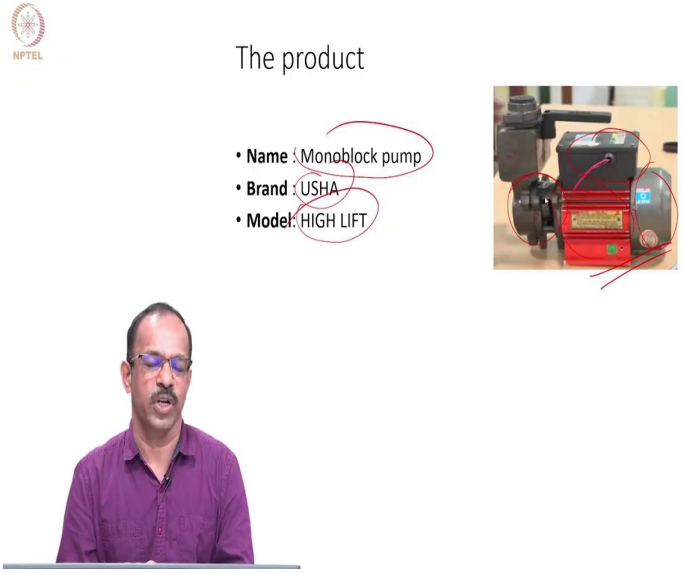

So, the Monoblock pump we are using is shown here so, this is again, an USHA make and it is a high lift model so that is the pump you can see. So you can see there is an electric part you can see there is an electric supply and then there is a motor and there is a pump body and then you have this assembly over here which will take input and then deliver the output.

And the mechanism varies it is not very complex. It is a simple mechanism because what you need is to rotate an impeller and then, take the liquid inside and then deliver it outside by increasing its kinetic energy and delivering it at a higher head. So the mechanism wise it is not very complex but, you will see that the concept that people are employing in order to get this is interesting. So, we will look into that the exercise and then try to identify the concepts.

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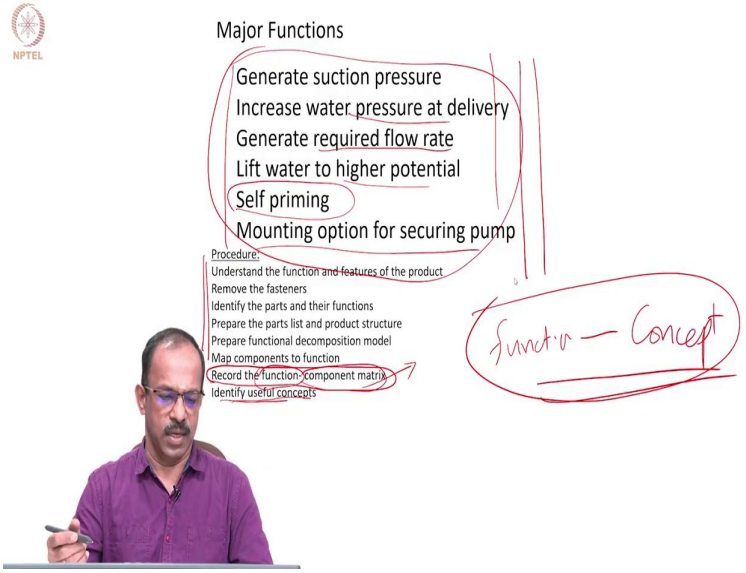

So, there are many functions to be achieved in order to deliver the liquid at a higher head, so that is primarily the function is to deliver a liquid or a solid at a higher head that is the purpose of a pump. Now, this particular pump if it is used only for the liquid, then it is only the liquid can be used, but there are more motors which can actually use semi-solid like cement and other things also so can be pumped.

There are many things that you need to generate the section head you need to increase the pressure at the delivery and you need to create the particular flow rate and you need to control the backflow and other things and something called priming may be required that is in some cases not all pumps need but, also the pump requires some kind of priming so, that is also to be achieved in the product.

And then mounting and then securing the pump to prevent vibration and other things, so these are the things which need to be satisfied in the product in order to get the main function of pumping liquid at a higher head. And as usual, we will go for the procedure most of the initial procedure remains same and then what do you need to do it right function to component matrix.

So now, this you might have done earlier also so, earlier what we used to do was a part to component you used to sorry part to function you need to map and here we can actually do the function and the component the same way you can actually look at the function and then see which component is providing that function and then, you will see that a particular

concept is employed in order to get that particular function so, that is where actually you identify the concept employed for achieving that function, so what is the concept employed?

So, more than looking at the part the component in that product, you look at okay what is the concept he has employed, so what is that concept and then identify those concepts and write down the main concepts used for the function. Finally, you need to in the useful concept you can say what is the function and what is the concept that actually he is employed to achieve that particular function can be mapped.

That way you will be able to identify all those concepts employed in the product and some of them will be useful for you in the in the future design of products that is where actually we will try to identify all the useful concepts and this will actually help you to develop a repository of concepts which can be used in product design at a later stage.

When you want to design a product, maybe not exactly a pump, but you may be doing something else and then you will be able to see that okay in this particular product, in order to reduce the vibration, they have used a particular concept. So, probably that concept, you may be able to use it in a different product so, that is the way you should look at this look at this exercise.

So, it not exactly to look at what is the concept that can be used for pump, the purpose is what are the concepts available in this design and which can be useful in many other fields also. So, that way you look at it and then identify all the concepts and then prepare the report and submit.

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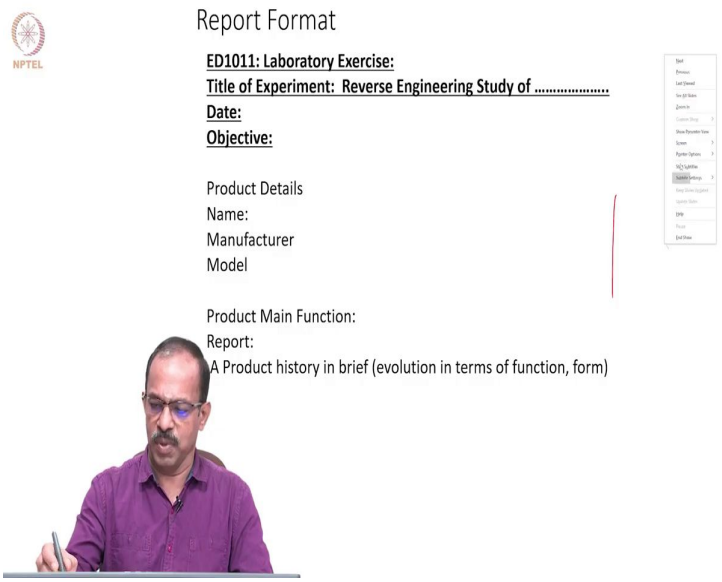

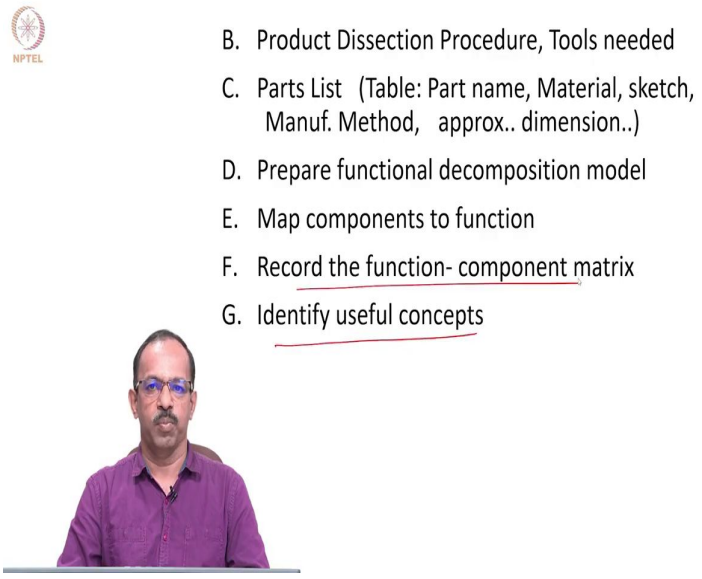

Report format as usual, be the same for the first part and then the second part will be having identifying the useful concepts and then recording it. This is what is expected from you in this exercise, I hope you will enjoy this and the TA will be showing you all the videos with the video of product dissection and identifying the parts and then looking at their functions. I hope you will enjoy this and thank you very much for listening to these lectures.

As I mentioned, this is going to be the last exercise for the laboratory session. Thank you very much and if you have any questions or if you want any clarification please feel free to write to me or you can write to the TAs and then they will be able to help you. Thank you very much.

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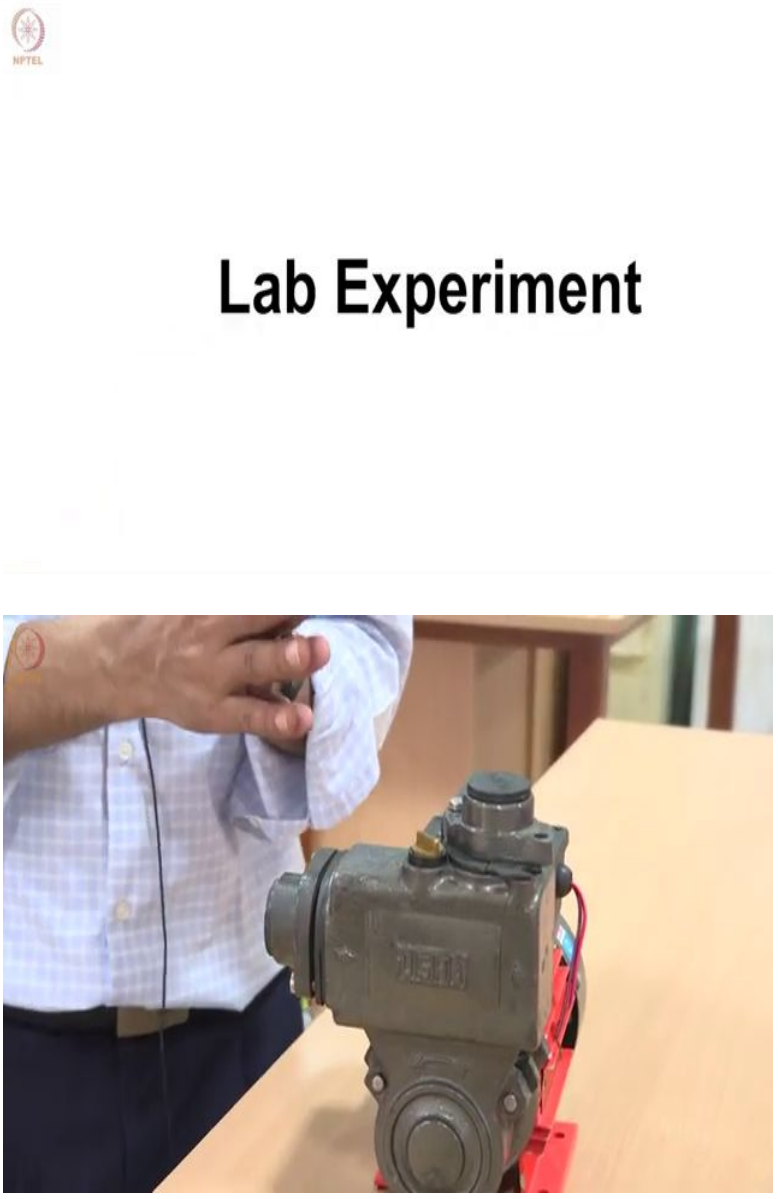

Welcome all! Today we will be learning about self-priming Monoblock pump so, you can have a look here. First, let me explain the nomenclature Monoblock means single piece. There is the entire thing for instance you have a thing called monolithic structures you go to for instance, you have certain Ajanta and Ellora caves you have in Mamallapuram you have monolithic structures, temple structures which is carved out of a single stone.

So, these are called monolithic or in other words Monoblock. So in other words these pumps do not have a coupling, the motor shaft directly is connected to the impeller and the entire thing is what we call as a mono block design so, we call these such designs as Monoblock design. Now, today what specifically we look at is, a pump that is self-priming, okay, before we get into the pump, let me explain what priming is, let may explain what priming is.

So, you might have seen when you install a pump for the very first time you have to basically pour water into the pump, why do we do that? Basically, we do what is called priming the pump, so why do we do that? So, normally there are several types of pumps so, this pump is placed above the water level it may be placed at ground level or slightly above ground level and the pipe that is connected from the pump to the water source that is called a suction head that length of the pipe that height is called suction head or the suction line.

So, this suction line normally has air in it, so pump these pumps or what is called non-positive displacement pumps. They do not they cannot suck air they can only suck medium such as water, so something that is slightly more denser. So the design allows them only to handle water. They cannot normally what we call the centrifugal pumps that you have

cannot or non-positive displacement or in other words they are centrifugal pumps cannot suck out air.

So, you have to basically fill the suction line and the impeller casing with water and then make sure you have a footwall at the bottom of the suction line to basically hold that water column and pump of such that whenever you start the pump up to the impeller casing it is filled with water and there is no what is called the airlock in the system at least in the suction side. Delivery side may not be filled with water it can be empty so, pump can basically pump water above the impeller above the volume case.

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USHA


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But today, we are going to look at a special type of a pump so, this is a pump where in you do not have to basically fill the entire suction line with water it is only enough that you fill this portion just by removing this so, you just have to fill in only this casing, just maybe half a litre of water you pour in so, you have a separate provision for that you open this you put a funnel and then you fill it with water, only this portion.

So, this is the suction line so, basically you can see the arrow that is marked inside so, water goes inside the pump this way and it exists the other way from the top. So, let me just remove this. This is what we call as a flange. Basically you are so it is threaded so, there is a female thread here. So basically we will connect a pipe here, this is a pipe thread national pipe thread NPT thread so it is a paper thread which is self-sealing you do not have to you only have to apply a sealant and then, when you screw in the pipe, it is self-sealing.

The thread has a taper to it, if you observe carefully; there is a mild taper to it. So that provides sealing between the pipe and the flange. Again you have what is called as this is a non-return valve, so when you assemble this so, you saw that it was placed this way so, this is this pump has not had been installed. It is important that you flip the non-return valve and then, put it this way.

Reason is, so non-return valve or check valve can only allow flow of water in this way. When there is a pressure differential, this is differential pressure operated right it opens by itself due to pressure differential and then, it opens this way, if I wrongly put it this way, what will happen it will try to suck water but, water cannot go this way it can only go this way.

Pay attention to the direction so, the valve has to be placed this way so, this is a non-return valve that basically ensures flow of water is only one way not the other way around. Now, let us continue dismantling it so, this is the casing so, as you can see so, there is a wall separating it water enters this way, you can see my finger come out this way so, look at the direction of rotation. It goes counter clockwise, the impeller rotates counter clockwise the impeller rotates counter clockwise.

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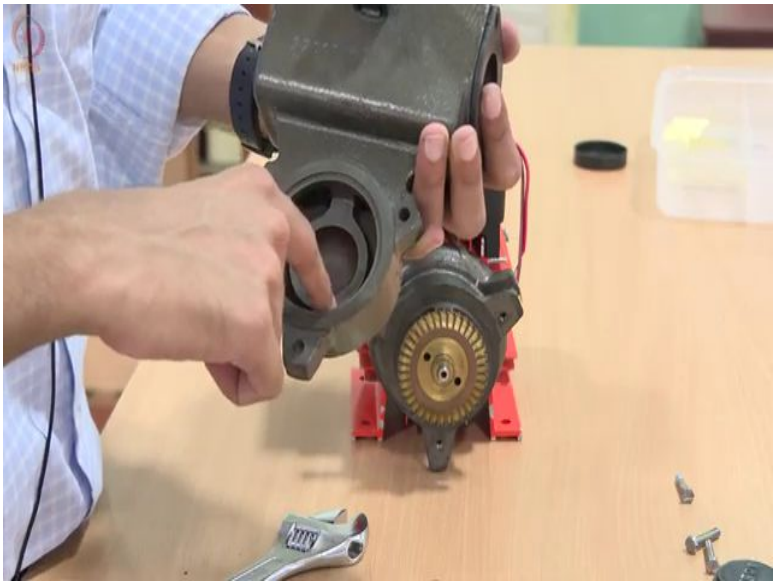

So, this is especially impeller so, these impellers you will only find in self-priming pumps. So water enters this way so, it basically enters tangentially here so, impellers carries the water remember this entire top portion and the casing is filled with water and then it goes around and then, exits and then comes out to through the top.

So, basically you can see there is a wall separating here so, water enters this way and see my finger here comes around the annular region and then again so, it enters a little bit tangentially right and then, again enters tangentially out a little bit not strictly tangential, but in a kind of almost, it is almost tangential.

So, the feature of this thing is by continuously circulating the water little by little the pump will evacuate the air that is there in the suction line. After you run the pump for maybe a minute or so, the water will keep circulating and slowly it will suck out the air and then water because it is dense enough will keep falling so water will not be discharged initially.

Once the entire suction is fully drained of all the air now it is filled with water, the pump now basically has primed itself. That is why we call it as a self-priming pump. In case of a centrifugal pump, what we have to do is we have to fill something like depending on the length of the volume of the suction line; you may have to fill something like 15-20 litres of water depending on how long it is. In this case because, of the designs, it allows just to fill very little quality of water and the pump self finds itself.

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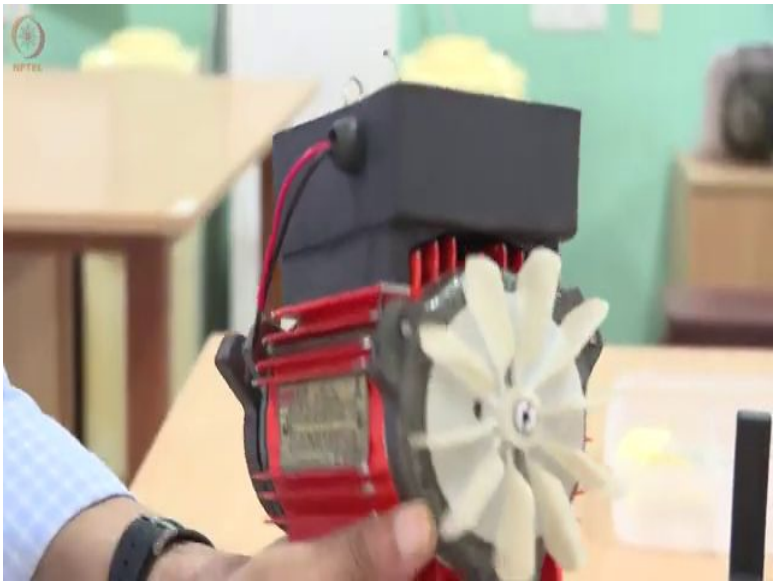

If you look at it, this does not have what is known as a volume case so, you can see the casing more or less it is uniform throughout in case of a volute casing you will have a gradually expanding outlet please take a look at the construction of a standard centrifugal pump it is called as a volute casing; v o l u t e, volute casing.

Again, that is pretty much to do with the impeller and the casing of the pump so, when you look at the motor this is a standard let us look at the nameplate, the nameplate says it is a single phase 0.37 kilowatt, 2 pole rated motor, why is there a 2-pole here? Because, we know from the other study that no single phase motor is self-starting you always have what is called as a capacitor start and run motor.

Basically you have two windings. **N**ow, you have a standard 10 micro farad electrolytic capacitor this capacitors are called electrolytic you can see so, it is filled with so, there is a coil of parallel plates that is in a coil form and there is a dielectric that is fills it so, this capacitor basically is connected to the starting winding and then, the other line it is connected to the running winding, so basically you have two windings.

Occasionally every 3 to 4 years you may have to replace the capacitor as it gets old. Now, let us quickly let me dismantle. The blower, basically cools the motor. **I**t is a common shaft on one side you have the impeller on the other side you have the blower you can see the fins here are much larger because, air is much less denser compared to water so, this handle is a much denser liquid.

This on the other handles a much less denser fluid so, basically, this is again a centrifugal fan so, air enters axially so, if this casing were not there what will happen? Air will enter axially and it will basically radially air will be blown out. Since, I have a casing what happens air enters axially it is thrown out radially the casing will again redirect there again back axially over these fins basically.

So, in operation if you keep your hand there you can feel the air flowing over the fins to basically cool the motor? The entire motor casing you can see it is made of aluminium and if you look at the cross section, it is of uniform cross section. So typically the entire casing is extruded, you have a single die. This will be one very long piece and then basically, they cut it into smaller pieces.

It becomes very cheap for the manufacturer to produce motors this way otherwise, if you had to cast it, you will have to basically create a casting for each and every motor that you need and the fin fins cannot be this thin. So, the thinner the fins the more efficient it will be, so these are aluminium fins, aluminium is a better conductor of heat so, compared to casting this is better and it is thinner and this and it is also thermodynamically very, very efficient.

I think the motor itself is a what is called as a squirrel-cage motor we have already looked at squirrel-cage motor in a table fan, construction wise it is literally the same as a table fan. So, we will not have a look at it. So, typically it will be the exact same thing the squirrel-cage motor as you have seen in a table fan so, mean construction wise it remains the same so, other than that, that pretty much is all you have to know about a self-priming Monoblock pump.

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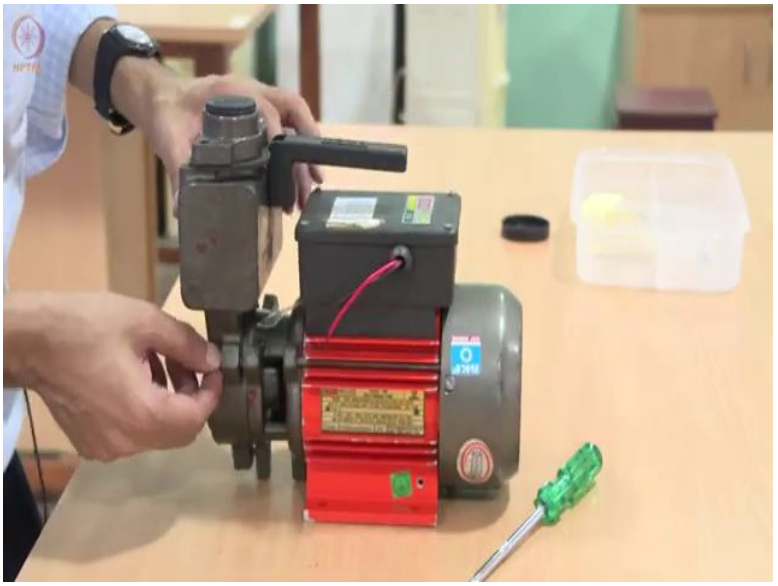

To summarize what we have learned today, basically, we have learnt about a self-priming mono-block pump that is capable of priming itself. In case of a normal centrifugal pump, a pump that is called a non-positive displacement pump, what is a non-positive displacement pump? The pressure is dependent on flow in case of a positive displacement pump pressure is independent of flow.

If I were to stop the flow at the outlet, the pressure will rise up to a certain extent and stop, in case of a non-positive displacement pump. In case of a positive displacement pump we favour to block the output, the pump will build pressure and after a while, basically it will depend on the motor, either the water will stall or the pump itself will fade.

That is something to keep in mind we all have a positive displacement pump within ourselves, it is basically the heart keep in mind a positive displacement pump works by varying a fixed volume, how does a heart work? By contracting and expanding. So, it changes it works by changing a fixed volume.

Heart is a positive displacement pump; why do we have a positive displacement pump? Because, now I am standing blood has to be pumped through all the veins in my body, there is a humongous back pressure that is there this pump is a non-positive displacement pump which means it cannot produce a very high pressure. Heart's role is to basically push blood through all capillaries and veins which are extremely small in size so, which means it is working under a huge amount of back pressure.

So, a positive displacement pump is preferred there and a positive displacement pump is self-priming keep that in mind. A non-positive displacement pump is not self-priming but this is a special construction of a non-positive displacement pump by way of construction of the impeller and the casing we convert non self-priming pump into a self-priming pump.

Nevertheless, remember this is again a non-positive displacement pump which means if I basically cut the output, it will develop pressure only up to a certain point and it will simply be circulating water there, so it cannot build up pressure beyond a certain point. It has limited applications. But, what is the good thing about it; is if you were to cut the output, the pump has some level of tolerance built into it.

For instance, if there is a block or a clog there, the pump will not destroys it so, it is ideal in a home use. In case of a non-positive displacement pump, if the pump, pumps daily very well to get blocked for whatever reason it will basically the pipe will blow up or the motor will stall and the coil will burn something will go bad in case of a positive displacement pump.

Again, one more thing to remember is in case of a non-positive displacement pump it does not work by varying a fixed volume, the volume is fixed, the casings volume is fixed. We have our impeller that basically rotates and creates suction in case of a positive displacement pump it creates suction by varying a fixed volume. So this is something you have to keep in mind. I hope you found that informative. Thank you.