Metal Casting
Dr. D. B. Karunakar
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee

Module – 01
Introduction And Overview
Lecture – 04
Overview Of Different Casting Processes-III

Welcome back friends, in the previous class we have seen the overview of the different casting process, now we will see the remaining process. Next we will learn about the evaporative pattern casting. What is this evaporative pattern casting?

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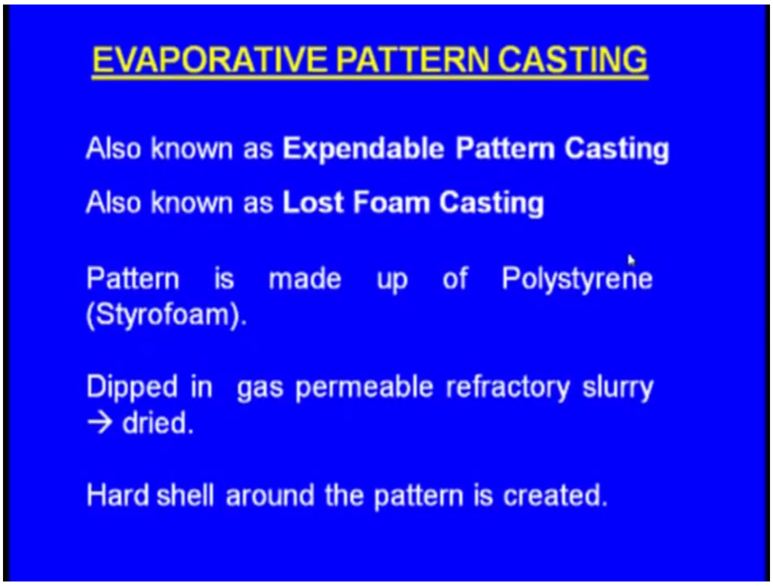

In this process we use an expendable pattern that is why this is also known as the expendable pattern casting, it is also known as the last foam casting; here the pattern is made up of the polystyrene it is also the Styrofoam, it is dipped in the gas permeable refractory slurry what say shell is created.

Then while the pattern is still present inside the shell the molten metal is poured, as the molten metal is entering into the shell where there is the pattern will be evaporated and the in the place of the pattern the molten metal will be occupying, because the pattern is evaporating. So, this is all also know that is why it is known as the evaporative pattern casting and here we can see yes, so this is the pattern this is the what say cast component we require, in a similar way we have made the a pattern polystyrene pattern and here we have made a cup and sprue right made up of the foam and here you say this whole thing is the foam pattern.

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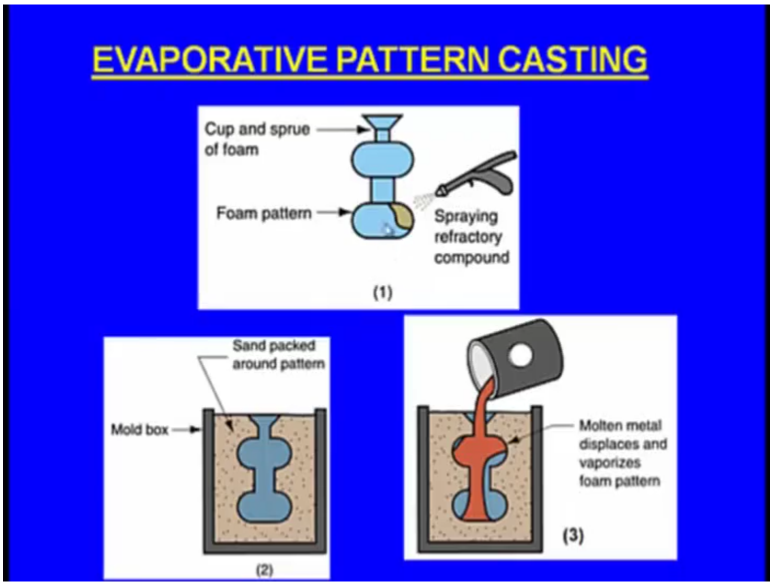

Now refractory slurry is spread around this pattern and it is what says repeatedly done. So, that a what say moderately thick shell is created around this foam pattern, now this form pattern is kept inside a molding box; molding box only single molding box no cope no drag only 1 molding box. In this molding box the sand is packed around this pattern remember the around the pattern, we have already made a what say moderately thick shell by means of a refractory slurry, now after packing the sand around this pattern now let us come here what is happening we will melt the metal and we will pour the molten metal into this pattern.

The most surprising thing is here the pattern is not removed, pattern means the model of the component which we are going to manufacture. Here the pattern is still present and we are pouring the molten metal inside, then what happens because of the evaporative nature of the pattern the pattern will be keeps on evaporating and makes a space inside, as it is evaporating as it is creating a hollow space inside the what say cavity inside the mould, the molten metal will be occupying that place and this process continues still more and more pattern evaporates and more and more molten metal occupies that the molten metal continues to occupy that place till the entire pattern is evaporated.

Now, after some time we what say solidification takes place and after solidification, yes we can take that out of the what say molding sand box molding box and we can break that shell and we will get a casting. So, this is the simple principle of the evaporative pattern casting because the pattern is evaporating while pouring we call it as the evaporative pattern casting.

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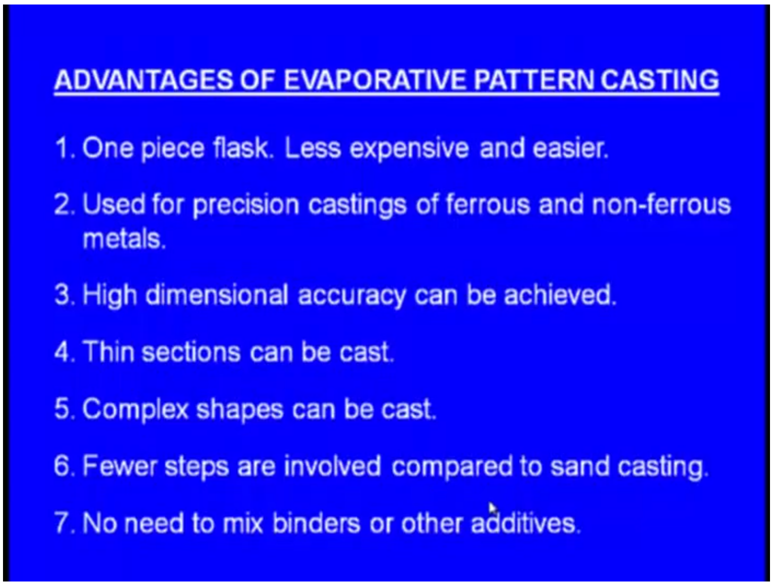

So, these are the advantages of evaporative pattern casting, here we use only one use one flask right. So, one piece flask that is why it is less expensive and also less laborious in the case of the sand molding process, we use generally 2 molding flask one the lower molding box that is the we call it as the drag and the upper molding box which we call it as the cope. So, we have to assemble them carefully otherwise there will be some displacement between these 2 boxes here such problem will not arise only one piece flask.

Next one used for precision castings of ferrous and non ferrous metals, both ferrous and non ferrous metals can be cast and that too we get you a very good precision and we get a next one we get the high dimensional accuracy, next one thin sections can be cast, next one complex of shapes can be cast because if it is the wooden pattern right. You once we make a complex wooden pattern and removal or the withdrawal of that complex pattern from the mould is very difficult, here we can make the pattern of any complexity then what happens while the pattern is still inside the shell we pour the molten metal. So, whether it is the shape is complex or simple it does not matter as we keep pouring the molten metal the pattern evaporates and escapes out of the box that is why it is very easy to make the complex shapes with this process.

Next 1 fewer steps are involved compared to the sand casting, in the case of the sand casting there are so many process, we have to prepare the molding sand and this molding sand has to be prepared very carefully, next one we have to prepare the course and we have to what say make the pattern and we have to mould it. Then we have to put the what say the runner pin on the sprue pin and the pattern should be withdrawn very carefully, if these are not withdrawn the mould cavities will be breaking and we may not get the what say desired casting.

So, these are all the problems with the sand casting whereas, here fewer steps no question of withdrawal of the pattern, that is the greatest advantage of this process because the pattern is continuously evaporating and no need to mix binders or the other additives. In the case of the what say sand molding we what say no doubt we use the base sand like silicon sand zircon sand chromium sand, then we add the binder like a clay Bentonite, then we also add the additives then we add the water then these are this all these ingredients are to be mixed very carefully and this takes lot of time and it also causes the pollution problem, but here there is no need to mix the binders just take the sand and pack it around the pattern power which a shell is created the process is that simple and here we can see an important application right.

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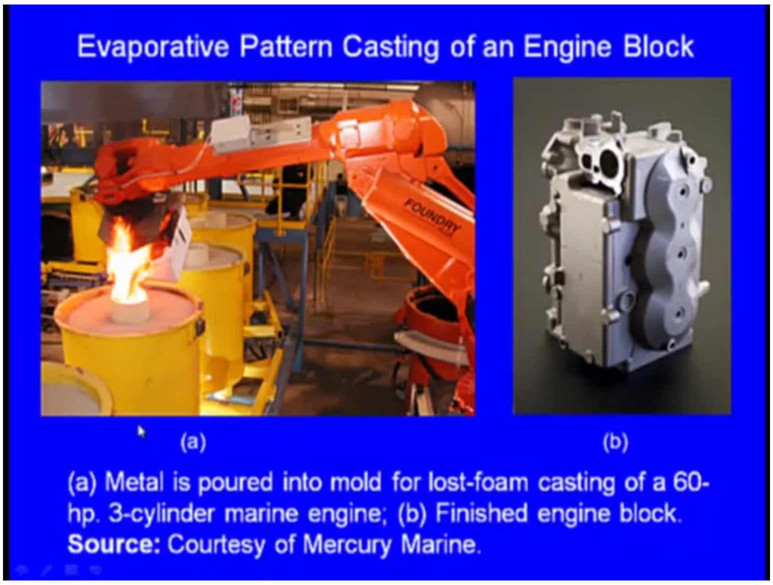

This is an engine block which is manufactured by the evaporative pattern casting right. So, you can see this here initially this is the one piece flask, this yellow colored one is the one piece flask inside there is the pattern, around which what say moderately thick shell is created and inside the pattern is still present while we are pouring the molten metal it is a robotic pouring right. So, as we keep pouring the molten metal your pattern evaporates and escapes out of what say box. So, this is what says very important application of the evaporative pattern casting.

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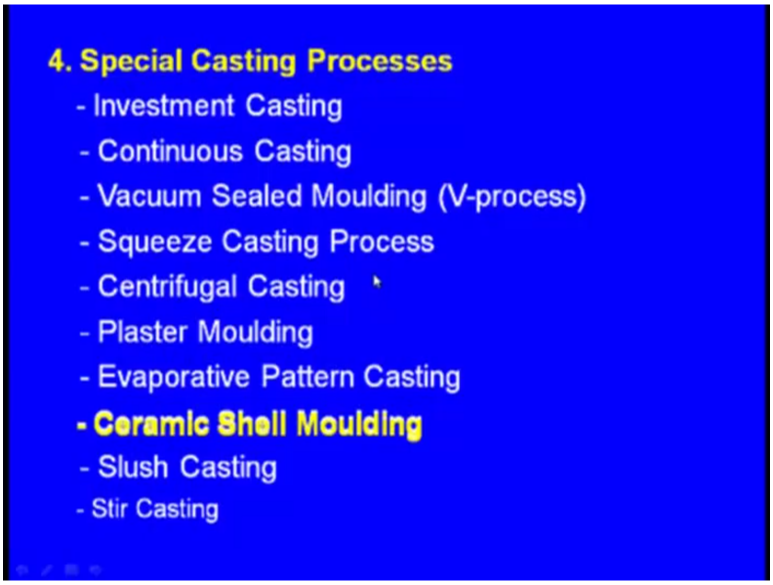

Next one let us see the ceramic shell molding, now remember that we are learning about the special casting process and we have already covered all this now we are learning about the ceramic shell molding.

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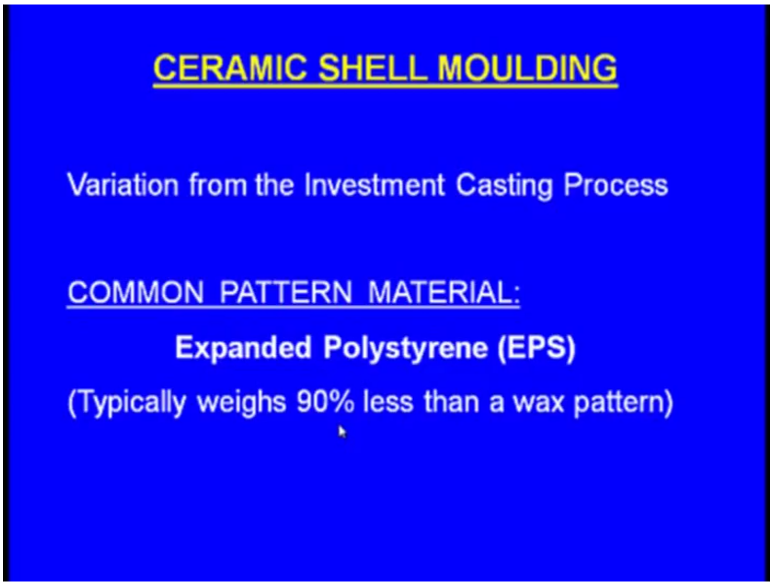

Is almost similar to the investment casting, but there is a little difference the common pattern material is the expanded polystyrene it is also known as EPS and the most important thing is it is weight is very less, 90 percent less than a wax pattern. So, that is the one good what say advantage of this process right.

So, these are the advantages of the ceramic shell molding, surface finish and dimensional tolerances are close to investment cast parts. We know that we have seen that in the investment casting process, we use the wax as the pattern material and we get a very good surface finish and also we get a very good dimensional accuracy and in the ceramic shell moldings also we get dimensional tolerance close to the investment casting process.

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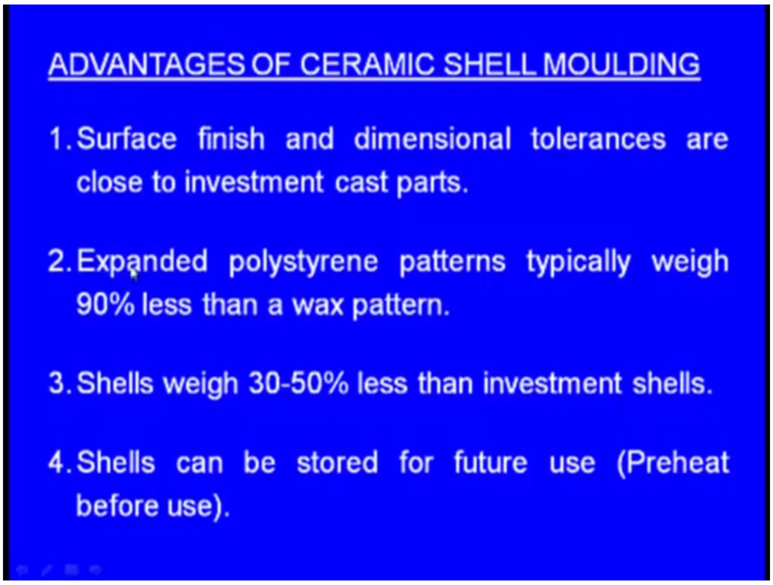

Next one the expanded polystyrene patterns typically weigh 90 percent less than the wax pattern, that is how handling of the wax patterns would be sorry not the wax patterns, these EPS patterns would be easier because their weight is 90 percent to less compared to the wax patterns.

Similarly, we have to create a shell in this process also around what say polystyrene pattern, these shells also weigh 30 to 50 percent less than the investment casting ceramic shells. So, handling them would be easier next one these shells can be stored for future use, they can be made well in advance only thing is when we one want to what say cast the component these shells should be preheated, then we can pour the molten metal. So, these are the advantages of the ceramic shell molding

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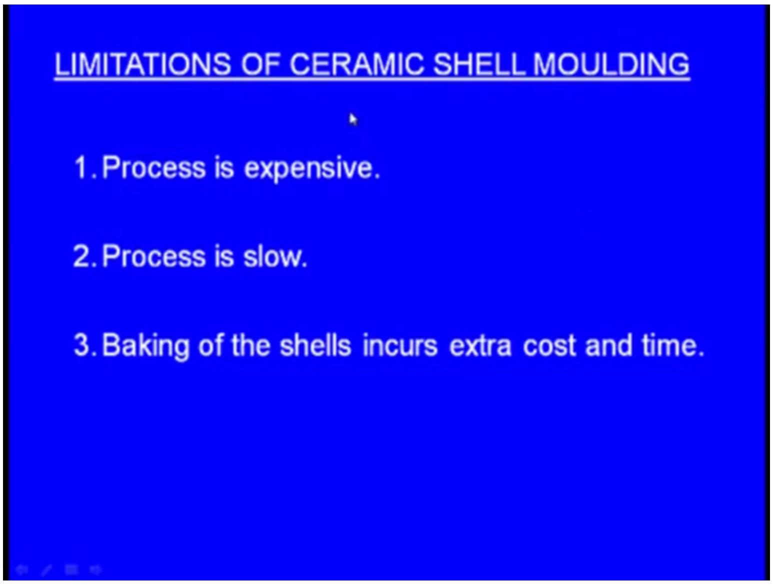

So, these are the limitations the process is expensive again, this is what say polystyrene pattern is expensive and the process is slow again and these shells should be baked. So, this costs extra time and also it consumes extra power. So, these are the limitations of the ceramic shell molding. Next to let us see the slush casting this one.

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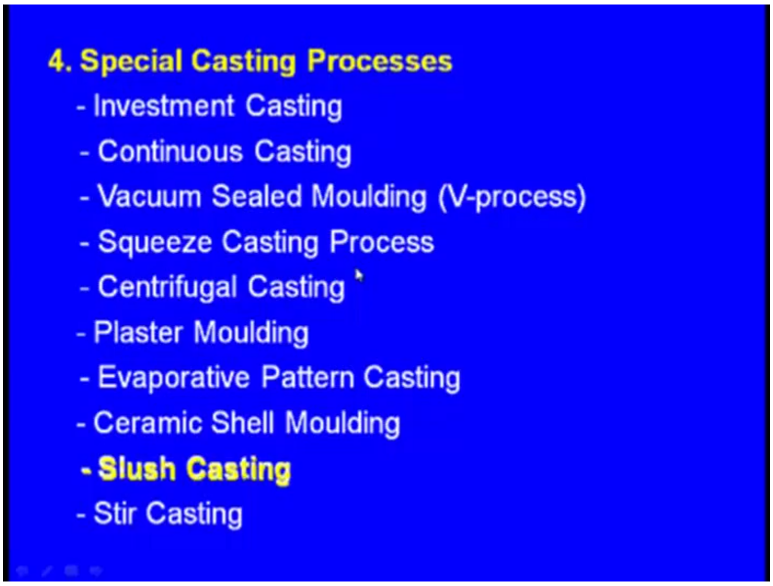

Now, this is another what say important and interesting in casting process, where we can create what say castings with hollow cavities without any cores, whereas in the case of the sand casting process we have to use cores means. So, what say some kind of pieces which are general made up of sand and these pieces are kept inside the mould, so that we can get hollow castings? So, that the molten metal flows around these what say sand piece and thereby there will be a hollow cavity inside the casting, here we get the hollow cavities without placing the cores. So, that is the interesting feature of the slush casting.

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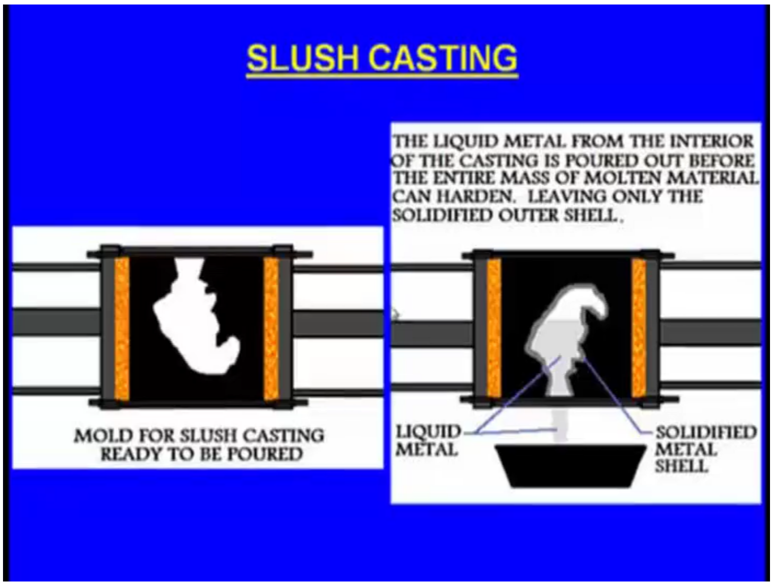

So, here we can see this is what says molding box right. So, this is the cavity mold cavity is already created. So, this is ready for pouring now here let us see what is happening, the liquid metal from the interior of the casting is poured right and before it solidifies then what happens it is made upside down, means the solidification starts from the mould wall and slowly the what say solidification increases and once the solidification reaches a what say thickness of a may be few mm inside still the molten metal is there, then we make the molding box upside down then the molten metal is present inside that flows out that will be draining out right. So, here the liquid metal is dropping down. So, this will be corrected in a container, now around say in close to the mould box here we can see there is a shell which has already solidified in the beginning.

Now, we can break this sand and we can take the casting outside. So, the casting has a hollow cavity inside without we need use of any cores. So, these are the advantages of the slush casting no cores are required, as I already told in the beginning no costs are required for making the hollow castings.

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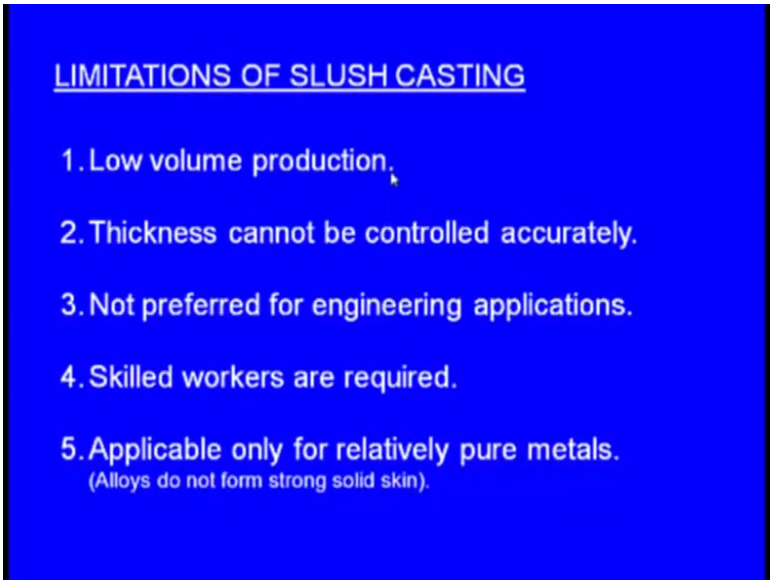

These are the limitations of the slush casting low volume production. Next one thickness cannot be controlled accurately right. So, just now we have seen that the solidification starts from the mould wall. So, slowly what say thickness of the solidified shell keeps on increasing, so we do not know at what time how much thickness what say has solidified? So, what say without what say much understanding and we have to what say make the box upside down, sometimes the thickness will be more sometimes the thickness will be less. So, the thickness cannot be controlled accurately.

Next one it is not preferred for the engineering applications it is used for the art applications art castings, next one in this process skilled workers are required applicable only for relatively pure metals because alloys do not form saw strong solid skin very quickly, whereas the pure metals they quickly form the what say strong solid skin near the mould walls and inside there will be liquid metal and that we can drain out by tilting the molding box.

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So, this is what says typical application of the slush casting. So, this is the decorative stand this is made by the slush casting. Finally we will see the stir casting, so this stir casting has been developed very recently and this is offering comparatively more advantages.

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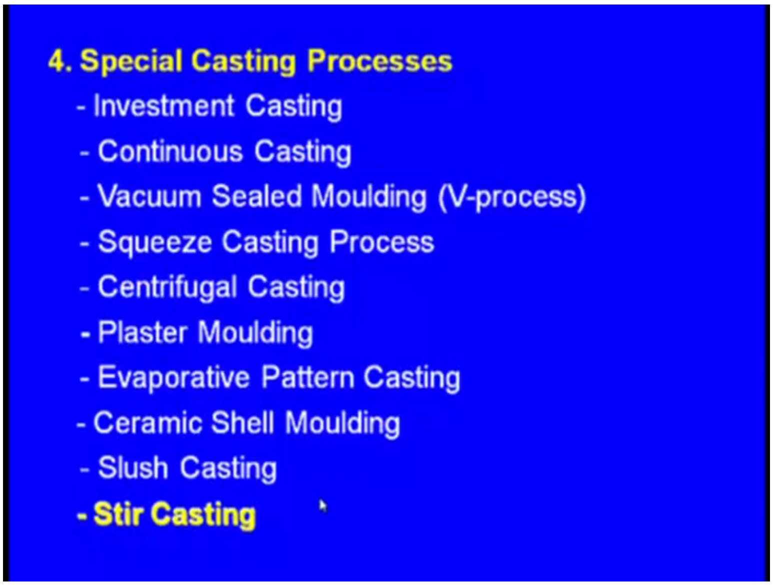

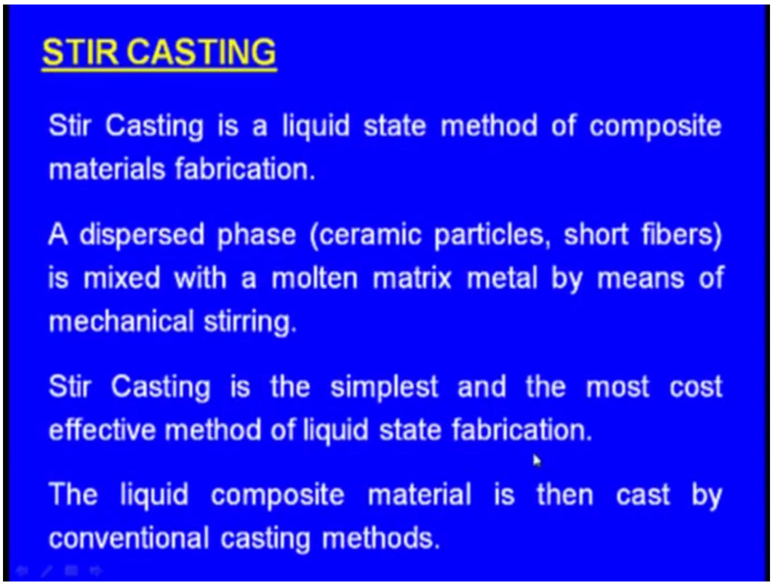

This stir casting is a liquid state method of composite materials fabrication, composites means the metal mixed with the ceramic. So, these offer better properties then the common alloys and the metals, a dispersed phase right ceramic particles are the short fibers they are mixed with the molten metal matrix by means of mechanical stirring. So, we melt the metal into the metal we add ceramic powder or the what say fibers and we stir it by mechanical stirring, the stir cat casting is the simplest and most cost effective method of the liquid state fabrication right. The liquid composite material is then cast by conventional casting methods, then once we mix this what say ceramics particles or the fibers then we can make the casting by the any of the conventional casting methods.

Only thing is instead of pouring a what say pure metal or an alloy we are pouring, what say composite what say metal means metal mixed with the ceramic particles or the fibers.

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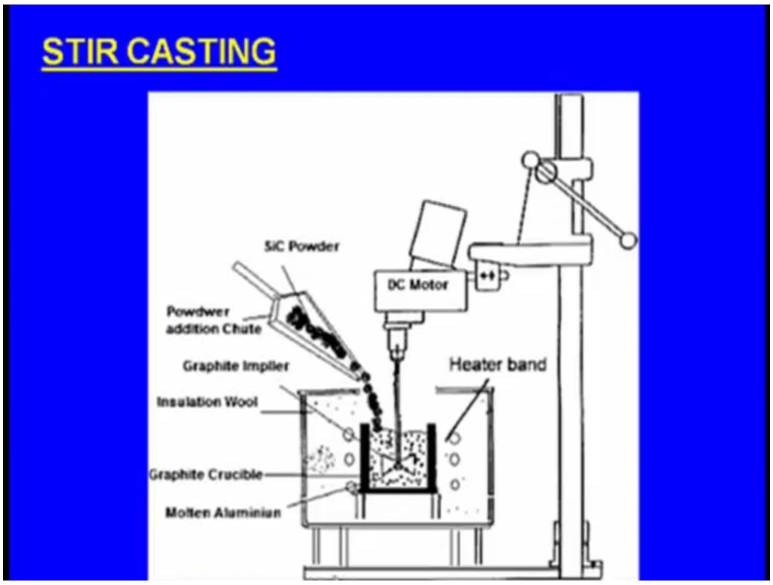

So, here we can see so this is the typical setup of the stir casting process and this is the what say molten bath, this is the crucible and here the molten metal is present and here we can see the powdered right ceramic particles are continuously added to the molten metal and here we can see a stirrer which is driven by a DC motor. So, this has got your blade and the as it is continuously rotating this mixture or this melt is continuously stirred and after sometime, so this the what say bath of the molten aluminum right. So, after sometime this bath of the molten aluminum gives melt will be taken and it will be poured into most of the what say poured into the most of the what say conventional molding methods.

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Now, these are the applications of the stir casting, stir casting is used for making the composite castings remember that composite means metal mixed with the ceramic.

Friends till now we have seen the what say classification and overview of different casting process, we are going to learn in detail about all these casting process in the subsequent lectures, we have seen the overview of the conventional molding process, we have seen the overview of the chemicals and molding process, we have seen the overview of the permanent modeling process and the next we have seen these special casting process and again we are going to learn all these process in detail in the subsequent lectures.

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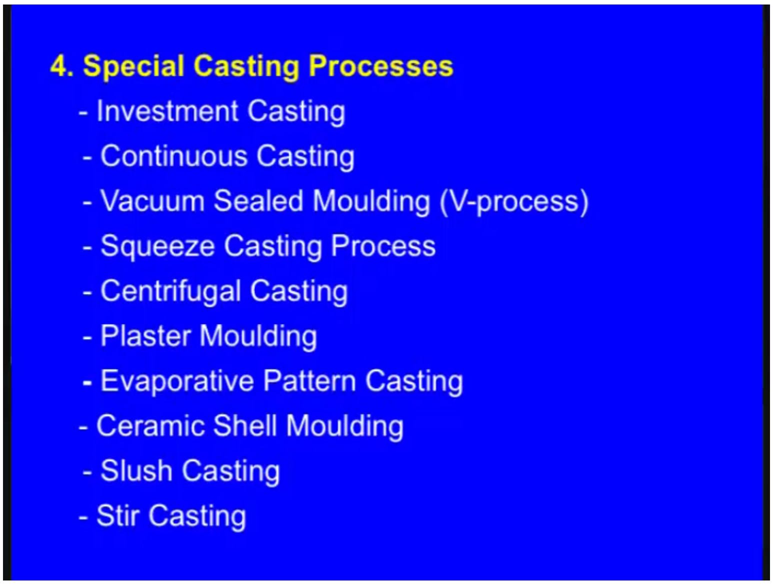

Next our next topic is the selection of the casting process, which process to use to make a particular casting. We have several casting process now right. So, for a particular process which process would be more what say economical are more what say which one would give the best towards a surface finish or the dimensional accuracy. So, this we need to study.

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Let us see the sand casting, sand casting it is suitable for most types of the metals and alloys except titanium alloys, next one it has got the moderate or the simple complexity right very complex castings it is not possible to make with the sand castings and what about the size small medium or large castings can be made, less than what say half a kg to 5 tons can be made by sand casting, quantities in the large medium are what say small ranges can be manufactured. Maybe if we want 5 castings yes you can make 5 castings or 50 casting or even thousand castings can be made. So, the flexibility with the quantity is there, flexibility with the weight is there with the sand casting process and it has got the surface finish is 120 to 350 RMS. So, this will be what says poor surface roughness.

Next one we need to give a draft to the pattern that is 0.25 to 5 degrees draft is to be given. So, that the pattern can be withdrawn from the mould and the what say moderate to low casting lead times, the lead time will be moderate to low. Next one moderate to low casting cost the casting cost is not very high it is moderate to low, next one the finishing cost is moderate to high of because we get what say rough surface finish we need to machine it. So, it will cost us right it is moderate to high.

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Next 1 the gravity die casting, it is suitable for aluminum copper base, magnesium and zinc alloys all the non ferrous alloys and it is used for the simple complexity and these small to medium casting sizes can be made 0.5 kg to 50 kg and what about the quantity, quantities medium to large ranges because this is what say moulds are made of special steels and making a cavity in these metallic moulds would be a difficult task and having made this metallic moulds with much effort and if we have to make only a few castings then it would not be economical.

These are the features surface finish between 150 to 250 RMS, better than the sand casting process. Draft of 2 to 4 degrees is required next one moderate tooling cost, next one low to moderate casting cost, next one moderate finishing cost.

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Whereas, in the sand casting process the finishing cost is high whereas, here the finishing cost is moderate, next one the pressure dies casting it is suitable for aluminum, magnesium and zinc alloys. So, there is a difference between the gravity die casting and the pressure die casting in the case of the gravity die casting the molten metal flows into the metallic mould by means of the gravity, here in the pressure die casting we apply external pressure because of this external pressure even if the what say mould cavity contains some complex features, the molten metal will be forced into these complex features that is how even complex shapes can be made by this pressure die casting right.

Next one simple to moderate complexity, next very small to medium casting sizes and quantities medium to very large range, once we make what say these dies. So, if we have to make only a few castings so it would not be economical, the quantity should be quantity of production should be either medium or should be large or very large then only the cost would be economical. So, these are the features surface roughness between 30 to 90 RMS. So, this is better than the sand casting process and also the gravity die casting process draft 0.5 to 3 degrees, next one high tooling cost low casting cost and low finishing cost.

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Next one the investment casting, it is suitable for iron steel aluminum copper based alloys, high alloy steels, magnesium steels, magnesium and titanium alloys. In fact, most of the cast alloys can be made using the investment casting process, moderate to high complexity because the pattern is made up of wax any complex feature can be made and around that we create the ceramic shell. So, the complexity is moderate to high, next one very small to medium casting sizes very large castings cannot be made right, very small castings can be made small castings can be made and also medium size castings. Quantities is from small to medium range very large production is not possible because the process is very slow, the pattern has to be made around that pattern we have to give a ceramic slurry coating, this is ceramic slurry preparation itself takes a lot of time then it has to be dried then it has to be baked. So, this process of making the ceramic shell takes about to 8 hours prior to I mean after making the ceramic slurry right. So, this process is slow that is why large production is not possible.

Next one these are the features surface roughness is between 63 to 125 RMS, next one thickness of the section is we, 0.75 mm means thin sections as thin as 0.75 mm can be cast. Next one moderate to high tooling cost low to high casting cost and moderate to high finishing cost. Next one centrifugal casting this is suitable for steel aluminum high alloy steels copper based alloys, it offers the simple complexity and the components must be x z symmetrical.

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Small to large casting sizes and quantities in the medium range, very large production may not be possible and these are the features surface roughness is between 100 to 300 r m s draft is 0 to 1 degree, moderate tooling cost moderate casting cost low to moderate finishing cost. So, these are the features of the centrifugal casting.

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Next one the plaster molding; this is suitable for aluminum, copper, magnesium and zinc alloys simple to moderate complexity, medium or small size castings can be made say 1 kg to 100 kgs quantities in small or medium range. So, these are the features surface roughness is between 63 to 125 RMS again we need to give you a draft of 0.5 to 2 degrees. Load tooling lead times and low moderate tooling cost, low to moderate casting cost and moderate finishing cost.

Next one let us see the last foam casting that is the expendable pattern casting or also it is also known as the evaporative pattern casting.

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So, this is suitable for iron and aluminum alloys, simple to moderate complexity small to medium casting sizes 1 to 500 kgs quantities in the small to medium range very large production is very difficult because the process is very slow. So, these are the features surface roughness between 100 to 300 RMS draft of 1 degree to be given, moderate to high tooling cost low to moderate casting cost and low to moderate finishing cost. So, these are the features of the what say evaporative pattern casting.

Now let us see the comparison of the different casting methods.

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	Sand casting	Die casting	Sand-shell	Investment casting
Tool costs	Low	High	Average	Average
Unit costs	Average	Low	Average	High
Maximum casting weight	over 1 tonne	30 kg	100 kg	45 kg
Thinnest section castable (mm)	2.5	0.8	2.5	1.6
Typical dimensional tolerance (mm)	0.3	0.25	0.25	0.25
Relative surface finish	Fair to good	Best	Good	Very good
Relative mechanical properties	Good	Very good	Good	Fair
Relative ease of casting complex designs	Fair to good	Good	Good	Best
Relative ease of changing design in production	Best	Poorest	Fair	Fair
Metal options	Most	Low	Average	High

So, these are the we have taken sand casting, die casting, sand shell and the investment casting. Now so, these are all the comparative features right. So, tool costs unit costs maximum casting weight right to thinnest section possible typical dimensional tolerance relate to surface finish, relative mechanical properties, relative ease of casting complex designs, relative ease of changing design in production metal options. So, these are the different what say feature coming to the sand casting the unit cost is average maximum casting weight over 1 ton. So, generally these, but nowadays even up to 5 tons people are making with the sand casting process.

Next one thinnest section possible is 2.5 m m, below that it is not possible with the sand casting process. Next one typical dimensional tolerance is 0.3 m m, relative surface finish fair to good, relative mechanical properties good, relative ease of casting complex designs these fair to good. Next one relative ease of changing design in production is best next one metal options most of the metals can be cast and coming to the die casting the tool costs are very high because the machine is very costly and the metallic moulds we have to make. So, this is what say machining these metallic moulds would be very very difficult and we have to use very sophisticated machines for that, that way the tool costs are very high next one unit costs are low maximum casting weight say 30 kgs very large castings cannot be made by die casting.

Now the thinnest section possible is 0.8 m m very thin section as thin as 0.8 m m can be made by die casting. Typical dimensional tolerance is 0.25 this is the variation, 0.25 m m. Next one relative surface finish this is the best among the all casting process. You can see the remaining process the sand casting process fair to good and what say sand shell it is good and investment casting very good whereas, die casting offers the best surface finish. Next one relative mechanical properties very good, next one what say ease of what say making complex shapes good next one relative ease of changing design in the process is poorest, because we make the metallic moulds. These metals moulds are made up of very high hard steels and we machine them we create the cavity using sophisticated machines, all of you sudden after making 10 cast some 10 castings someone says no no change the casting design these what say feature needs some modifications, it is very difficult. So, that is why change of designs during the process is the poorest.

Next one metal options what say it is low; next one sand shell process right means the chemical what say sand casting process the shell molding next one the tool costs are average, unit costs are average, maximum cast weight is casting weight is 100 kgs, thinnest section possible is 2.5 m m typical dimensional tolerance it is 0.25 m m. So, this much can vary after we make the casting. Relative surface finish good relative mechanical properties good, relative ease of casting complex design is good, relative what say ease of changing the design is fair. Next one metal option average means not be all the what say alloys and what say average the number of alloys can be manufactured using this shell molding process.

Finally let us see the investment casting process, the unit costs are the tool costs are the average unit costs are very high, you see because we have to make the wax pattern. Sometimes we use several waxes and make the blend. So, these wax are very costly these wax are very costly, next one and next we have to make the ceramic shell on a slurry then we have to apply a coating around wax pattern. So, this the ingredient of the ceramic shell are very costly that way the unit cost is high next one maximum casting weight is see this is the typical weight what 45 kgs, but nowadays even people are making about 300 kgs, 300 kgs to 400 kgs in some special cases.

Now the thinnest section possible is 1.6mm, typical dimensional tolerance 0.25 mm this much variation will be after we make the final casting. Relative surface finish very good the surface finish that is obtained in the investment casting is next to the surface finish which is obtained in the die casting. Relative mechanical properties are fair relative ease of casting complex design is best next one relatively ease of changing design during the production is fair, next metal options is very high. As I already told in the beginning most of the engineering alloys can be made by investment castings.

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Next one let us see the economics of the casting process; these are the what say a cost components one is the moulds right. So, it could what say in the case of the sand casting process right it would be extreme right sorry in the case of a sand casting process it would be low mould cost whereas, if it is the die casting process the mould cost is very high. So, this is one component of the cost, next one melting and pouring. So, this is costly melting and what say it consumes lot of power, next one heat treatment. So, this also involves cost next one cleaning inspection and finally, the labor charges.

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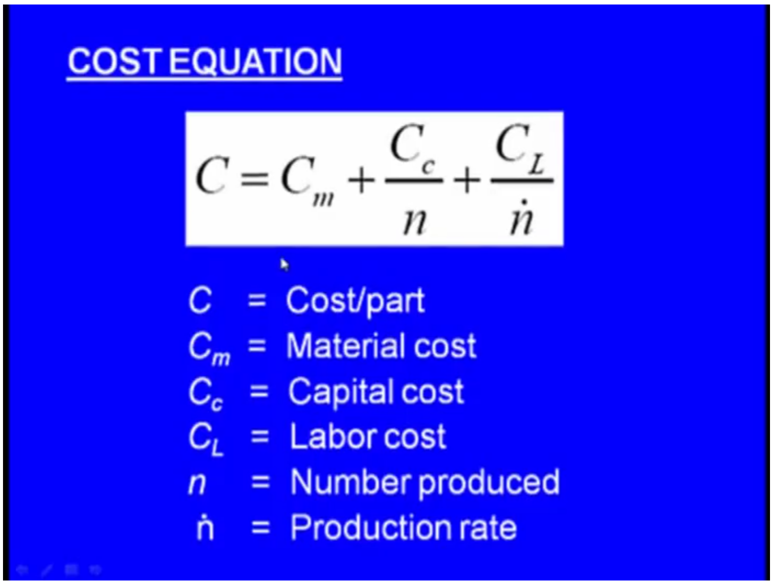

So, these are all the what say cost components and the total cost is dependent on all these factors. So, this is the cost equation we can see here C is equal to C m plus CC divided by n plus C L divided by n where C is the cost per part, C m is the material cost, CC is the capital cost, C L is the labor cost n is number produced means this number and this n the second one is the production rate. So, this the cost equation.

Now, this we can say see the what say comparison of important casting process by this graph right. So, this x axis shows the number of components whereas, the y axis shows the relative cost per component.

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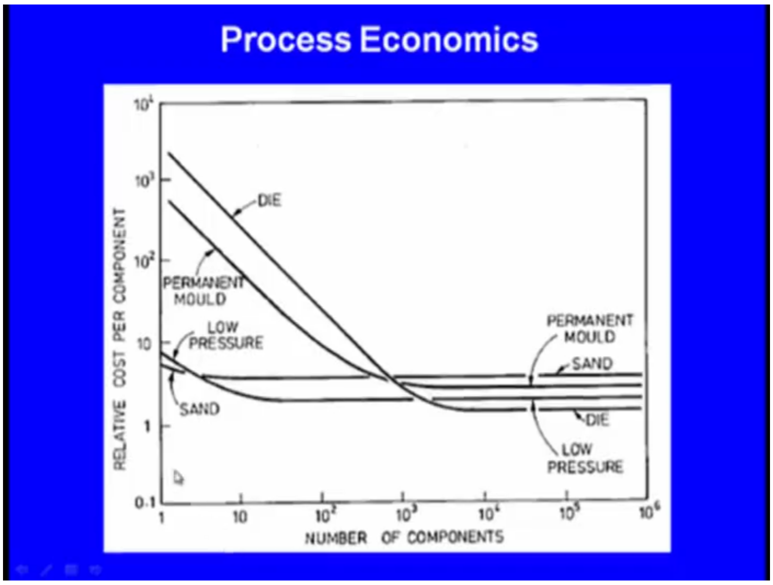

Now, let us see what is happening with the sand casting process. So, in the beginning if you make only say less than 10 castings the cost is very high not very high moderately high and as you keep increasing the components, it is little what say less and it continues to be the same even if we make say 1 lakh components right. Whereas, let us say this one permanent mould process, if we see because the what say dies are moulds are made up of the metallic ones and here if we make say less than say 100 components or 10 components the cost would be very high, but the same moulds without breaking can be used for making hundreds and thousands of components. So, as we keep increasing the components the cost would come down the cost per component would come down.

Now this is the pressure die casting; the pressure die casting that machine is very costly because of most of the again this pressure die casting is cold chamber pressure die casting and hot chamber pressure die casting. In the hot chamber pressure die casting the melting furnace is the integral part of the machine whereas, in the cold chamber die casting machine the melting furnace will be outside. So, if we consider the hot chamber the casting process, the melting furnaces inside that machine is very very costly. Now if such a machine if we buy and if we make only 100 components cost would be very high.

On the other hand if we make say 1 lakh components the same moulds can be used the same machine can be used the moulds need not be broken after the solidification that is how the speed of production would be very high and the cost per component drastically comes down. It comes down drastically that if the cost of the production would be even lesser than the cost of the sand casting process here we can see this is the die casting you see in the beginning it is very high, but as you increase the number of what say components, it is coming down under the cost involved per part is less than the cost of the sand casting process.

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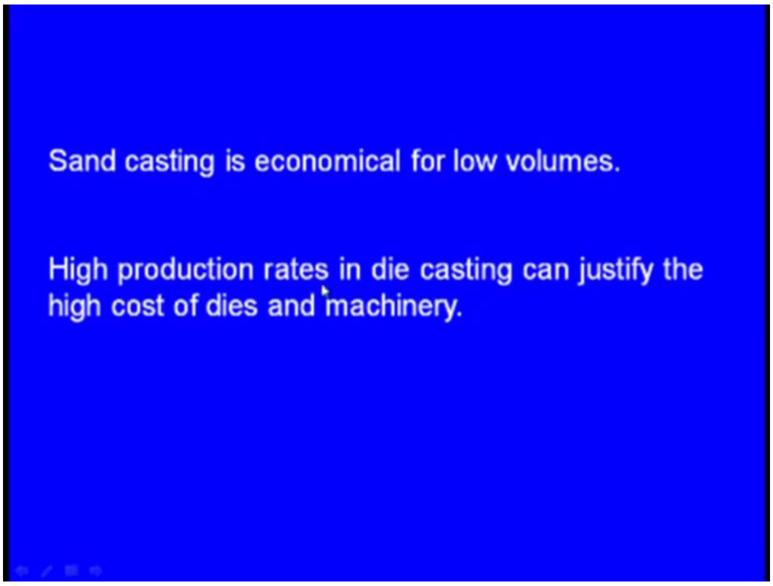

So, what we can conclude? Sand casting is economical for the low volumes whereas, high production rates in die casting can justify the high cost of dies and the machinery and once we go for the high production rate in the die casting the pressure die casting the cost would be much lesser, lesser than the cost of the sand casting process.

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Next one important considerations for the casting alloys. So, these are the important considerations when we are making the cast alloys. Casting characteristics are important next one machinable casting characteristics means the surface finish the dimensional accuracy the ability of making some complex features are the thin sections. So, these are the casting characteristics.

Next one machinability; most of the cast components after we make the casting they need the machining to get the required surface finish. So, the cast alloy should have the good machinability. Next one sometimes the cast components will be welded to some other cast components or some other components, then they should have the good weldability.

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Typical applications of cast alloys & characteristics

Type of alloy	Typical applications	Casta-bility	Welda-bility	Machina-bility
Aluminium	Pistons, clutch housings, intake manifolds	E	F	G-E
Copper	Pumps, valves, gear blanks, marine propellers	F-G	F	F-G
Ductile iron	Crankshafts, heavy-duty gears	G	D	G

E=Excellent, G=Good, F=Fair, VP=Very poor, D=Difficult

So, these are the again important considerations these are the typical applications of the cast alloys and the characteristics now let us see this aluminum. So, these are the typical applications we can make pistons, clutch housings right intake manifolds right the cast ability is excellent; E mean excellent, G means good, F means fair, VP means very poor D means difficulty for the aluminum alloys the weldability is fair and the machinability is good to excellent.

Next one copper alloys, it is used for making pumps valves gear blanks marine propellers the cast ability is fair to good, weldability is fair and the machinability is fair to good. Next one let us see the ductile iron this is the typical applications or the crankshaft heavy duty gear the cast ability is good weldability is difficult and machinability is good.

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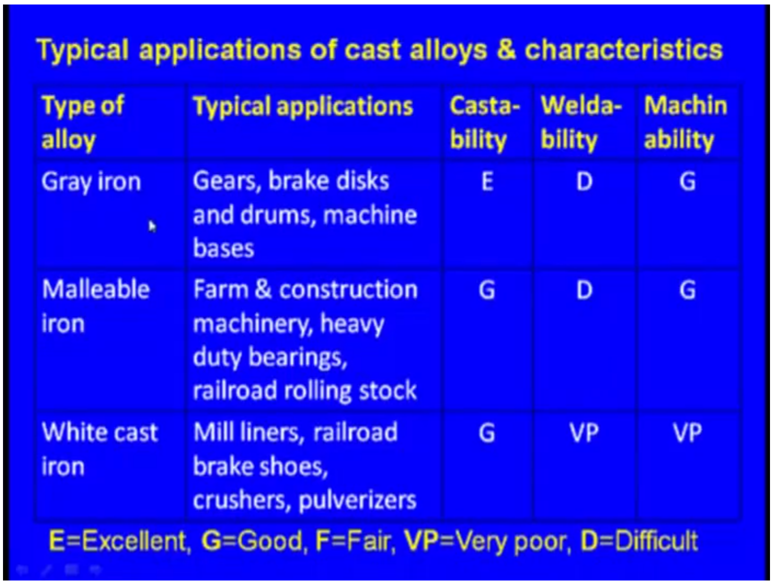

Typical applications of cast alloys & characteristics

Type of alloy	Typical applications	Casta-bility	Welda-bility	Machin ability
Gray iron	Gears, brake disks and drums, machine bases	E	D	G
Malleable iron	Farm & construction machinery, heavy duty bearings, railroad rolling stock	G	D	G
White cast iron	Mill liners, railroad brake shoes, crushers, pulverizers	G	VP	VP

E=Excellent, G=Good, F=Fair, VP=Very poor, D=Difficult

Next let us see the gray iron; these are the typical applications gears brake disks and drums machine basis, these are manufactured by gray iron or the gray cast iron, the castability is excellent, weldability is difficult and machinability is good. Next one malleable cast iron these are the typical applications farm and construction machinery heavy duty bearings, railroad rolling stock these are manufactured by malleable iron and the castability is good, weldability is difficult, machinability is good.

Next one white cast iron; in the white cast iron in all the cast irons carbon is present, in the white cast iron carbon is present in the form of the cementite. So, because of the presence of this cementite, the white cast iron becomes very hard. So, these are the typical applications, this is used for making mill liners railroad brake shoes. So, these are the very hard components. In fact, these components require a high hardness and crushes pulverizers. So, these are all manufactured by white cast iron and cast ability is good weldability is very poor machinability is very poor yes because of the presence of the cementite the machinability would be very very poor.

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Typical applications of cast alloys & characteristics

Type of alloy	Typical applications	Casta-bility	Welda bility	Machina-bility
Steel (Carbon & low-alloy)	Die blocks, heavy-duty gear blanks, aircraft undercarriage members,	F	E	F
Steel (high alloy)	Gas-turbine housings, pump & valve parts, rock- crusher jaws	F	E	F
Magnesium	Crankcase, transmission housings	G-E	G	E

E=Excellent, G=Good, F=Fair, VP=Very poor, D=Difficult

Next let us see the steel carbon alloys, these are the typical applications die blocks, heavy duty gear blanks aircraft to undercarriage members these are the typical applications and the cast ability is fair, weldability is excellent, machinability is fair. Next one steel high alloy steels. So, these are the typical applications gas turbine housings pump and wall parts rock crusher jaws and castability is fair, weldability is excellent, machinability is fair. Next one the magnesium alloys these are the typical applications crankcase transmission housings the castability is good to excellent, weldability is good and the machinability is excellent.

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Typical applications of cast alloys & characteristics

Type of alloy	Typical applications	Casta-bility	Welda-bility	Machina-bility
Zinc	Door handles, radiator grills	E	D	E
Nickel	Gas turbine blades, pump and valve components for chemical plants	F	F	F

E=Excellent, G=Good, F=Fair, VP=Very poor, D=Difficult

Next let us see the remaining alloys these are the zinc alloys and the nickel alloys. Coming to the zinc alloys these are the typical applications door handles and radiator grills. So, these are manufactured by zinc alloys, the castability is excellent, weldability is difficult and the machinability is again excellent.

These are the nickel alloys, the these are typical applications right gas turbine blades pump and wall components for chemical plants, these are manufactured by nickel alloys what about castability? Fair what about weld weldability? Fair and machinability is also fair.

Friends with this lecture we have seen the what say concept of the casting process the principle of the casting process and we have seen how the casting process has developed and how it has changed in the what say past history right and different casting process have been developed and we have seen the classification of these different casting process, we have also seen the overview of the all these casting process and there what say comparison and the economics of these casting process we have seen and the typical applications also we have seen and in the next classes and we will be concentrating on the what say each and every casting process in detail we will be learning.

Thank you.