**A**

**Seminar report**

**On**

# Hovercraft

Submitted in partial fulfillment of the requirement for the award of degree
Of Bachelor of Technology in Mechanical

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# Acknowledgement

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Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

# Preface

I have made this report file on the topic **Hovercraft;** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

# CONTENTS

# INTRODUCTION

A Hovercraft is a vehicle that flies like a plane but can float like a boat, can drive like a car but will traverse ditches and gullies as it is a flat terrain. A Hovercraft also sometimes called an air cushion vehicle because it can hover over or move across land or water surfaces while being held off from the surfaces by a cushion of air. A Hovercraft can travel over all types of surfaces including grass, mud, muskeg, sand, quicksand, water and ice .Hovercraft prefer gentle terrain although they are capable of climbing slopes up to 20%, depending upon surface characteristics. Modern Hovercrafts are used for many applications where people and equipment need to travel at speed over water but be able load and unload on land. For example they are used as passenger or freight carriers, as recreational machines and even use as warships. Hovercrafts are very exciting to fly and feeling of effortlessly traveling from land to water and back again is unique.

# HISTORY

In the beginning……

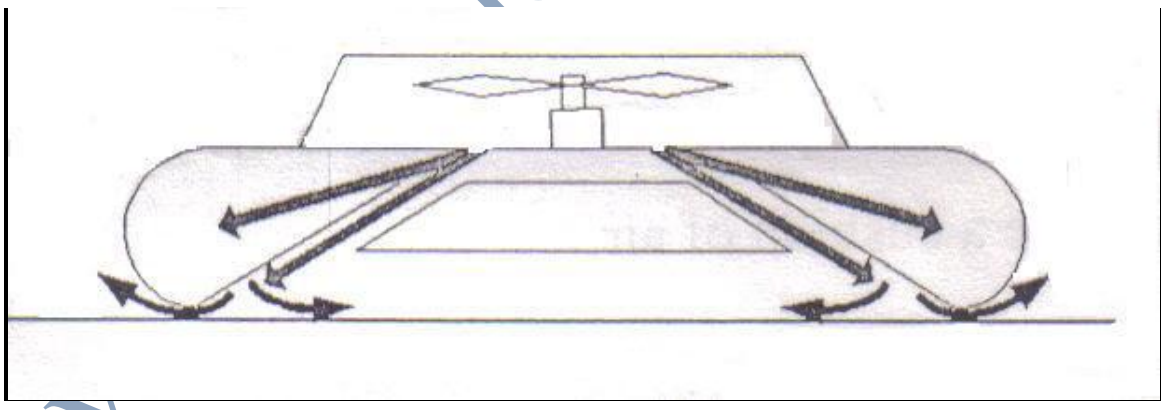
Hovercraft as we know them today started life as an experimental design to reduce the drag that was placed on boats and ships as they ploughed through water. The first recorded design for an air cushion vehicle was put forwarded by Swedish designer and philosopher Emmanuel Swedenborg in 1716. The craft resembled an upturned dinghy with a cockpit in the centre. Apertures on either side of this allowed the operator to raise or lower a pair of oar-like air scoops, which on downward strokes would force compressed air beneath the hull, thus raising it above the surface. The project was short-lived because it was never built, for soon Swedenborg soon realized that to operate such a machine required a source of energy far greater than that could be supplied by single human equipment. Not until the early20th century was a Hovercraft practically possible, because only the internal combustion engine had the very high power to weight ratio suitable for Hover flight.

In the mid 1950s Christopher Cockrell, a brilliant British radio engineer and French engineer John Bertin, worked along with similar line of research, although they used different approaches to the problem of maintaining the air cushion. Cockrell while running a small boatyard in Norfolk Boards in the early 1950s began by exploring the use of air

lubrication to reduce the hydrodynamic drag, first by employing a punt, then a 20 knot ex-naval launch as a test craft.

# PRINCIPLE OF WORKING

The principle of working of a Hovercraft is to lift the craft by a cushion of air to propel it using propellers. The idea of supporting the vehicle on a cushion of air developed from the idea to increase the speed of boat by feeding air beneath them. The air beneath the hull would lubricate the surface and reduce the water drag on boat and so increasing its speed through water. The air sucked in through a port by large lifting fans which are fitted to the primary structure of the craft. They are powered by gas turbine or diesel engine. The air is pushed to the under side of the craft. On the way apportion of air from the lift fan is used to inflate the skirt and rest is ducted down under the craft to fill area enclosed by the skirt.



At the point when the pressure equals the weight of the craft, the craft lifts up and air is escaped around the edges of the skirt. So a constant feed of air is needed to lift the craft and compensate for the losses. Thus craft is lifted up. After the propulsion is provided by the propellers mounted on the Hovercraft. The airs from the propellers are passed over rudders, which are

used to steer the craft similar to an aircraft. Hovercraft is thus propelled and controlled and its powerful engine makes it to fly.

# MAIN PARTS

**Lower hull-** It is the basic structure on which the Hovercraft floats when the engine is stopped while moving over water. It supports the whole weight of the craft.

**Skirts-** They are air bags inflated by air are fitted around the perimeter of the craft hold air under the craft and thus upon a cushion of air. It enables to obtain greater Hover height. The material used is rib stop nylon or Terylene.

**Lift fan-**It is fitted to the primary structure of the Hovercraft. The air is pumped under the craft between the skirt space to produce a cushion of air.

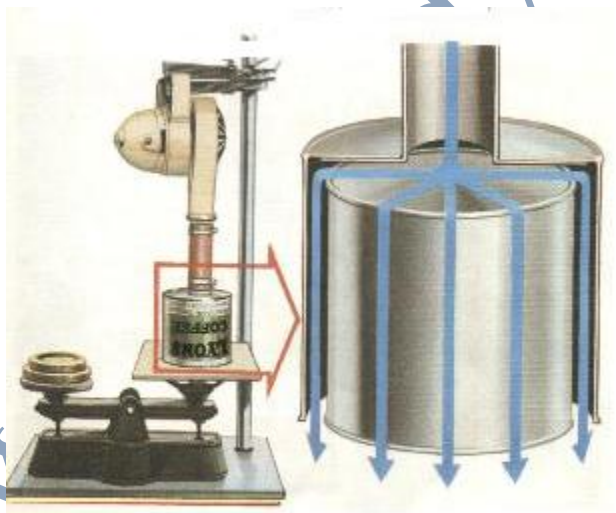
**Propeller-**It is used to obtain the forward motion of the craft. It is fitted to the top of the craft and is powered by a powerful gas turbine or diesel engine.

**Rudders-**They are similar to that used in an aircraft. Rudders are moved by hydraulic systems. By moving the rudders we can change the direction of the craft.

# DEVELOPMENT OF AIR CUSHION BY MOMENTUM CURTAIN EFFECT

Stability of the Hovercraft on its cushion of air remained a real problem despite some design efforts and new approach was needed. To solve these problems, plenum chamber with a momentum curtain was developed by Sir Christopher Cockrell.

His first experiments were conducted with the aid of two cans and a vacuum cleaner (with blower end). The cans were drilled and bolted so that one can was inside the other with open ends facing down to some weighing scales, the top of the larger can was open and had a tube connected to it so that air could be forced in to the top can and around the smaller can inside.



The air traveled around between the inside of the bigger can and outside of the smaller can and was then let out towards the scales in a narrow ring of air, the cans were mad4e so that it was possible to remove inner can so the air could be directed in two ways.

The experiment was conducted in two steps. First the smaller can was removed and blower switched on. The scales measured the amount of thrust the air from the one can produced down onto the scales. The smaller can was now replaced inside the larger can so that the ring of air was produced. Again the blower was switched on and the scales measured amount of thrust the ring of air produced down onto the scales. Here is the key discovery because Cockrell observed that the two cans nested inside each other produced more thrust onto the scales than the simple open can or plenum chamber did, he had discovered the momentum curtain effect and this was the key ingredient that he patented.

In the full size craft the plenum chamber was also filled in so that a slot round the bottom edge of plenum chamber wall was former where the air fed in at the top. The slot produced a curtain of flowing air that was inclined. The high pressure air from the slot angled inwards towards the centre of the craft helped to contains and sustains the air cushion. Using this method a stable air cushion could be created. The craft was still riding on a plenum chamber of sorts but it was created and maintained by the high pressure ring of air surrounding the lower pressure air in the center.

The momentum curtain arrangement achieved higher hover heights with less power. It also solved some of the stability problems. The box structure in the center of the craft around which air escaped was closed to

form a buoyancy tank to enable the craft to float on water when it came to rest.

The design was exactly what was used in first publicly demonstrated Hovercraft the SRN1, built by Saunders Roe in the United Kingdom it served as a test bed for many years during Hovercraft development.

# HULL CONSTRUCTION

The lower hull of the craft includes the craft floor, side panels, forward and aft panels till the top skirt attachment line. Most commercially build craft in polyester resin will use this section to transfer to the top hull. The lower hull

- Needs to have adequate size for the total weight of the craft and payload
- Must be strong enough to support craft off cushion (on landing pads)
- Have enough freeboard to support craft in displacement mode on water
- Must be watertight and as smooth as possible.

The lower hull can be build out of all boat building materials. From simple ply to very complicated composite panels.

# HOVERCRAFT SKIRTS

Despite the momentum curtain being very effective the hover height was still too low unless great, and uneconomical, power was used. Simple obstacles such as small waves, or tide-formed ridges of shingle on a beach, could prove to be too much for the hover height of the craft. These problems led to the development of the skirt

A skirt is a flexible shaped strip fitted below the bottom edges of the plenum chamber slot. As the Hovercraft lifts, the skirt extends below it to retain much deeper cushion of air. The development of skirts enables a Hovercraft to maintain its normal operating speed through large waves and also allows it to pass over rocks, ridges and gullies.

Skirt is one of the most design sensitive parts. The design must be just right or an uncomfortable ride for passengers or damage to craft and skirts results. The skirt material has to be light flexible and durable all at the same time. For skirt to meet all of the requirements the design and use of new materials has slowly evolved.

There are three types of skirts

- Bag skirt
- Finger skirt
- Bag and finger skirt

**A Hovercraft skirt is required to fulfill the following functions**

- Contain the cushion of air beneath the craft at required Hover height
- Have the ability to confirm or contour effectively over obstacles so as to keep minimum, the loss of cushion air
- Return to its original shape after having been deformed
- Give adequate stability
- Offer little resistance to passage of obstacles beneath it
- Have the ability to absorb a large portion of the energy which is produced on impacts or collision with obstacles greater than hover height or cushion depth.

# THE LIFTING FAN

In the enclosed space fan operates in a propeller would not be suitable. Firstly the volume of air needed is very large and a propeller is designed to be most efficient in open air like on an aircraft. Propellers again are not efficient in applications when an air backpressure will be applied to the propeller blades as they rotate.

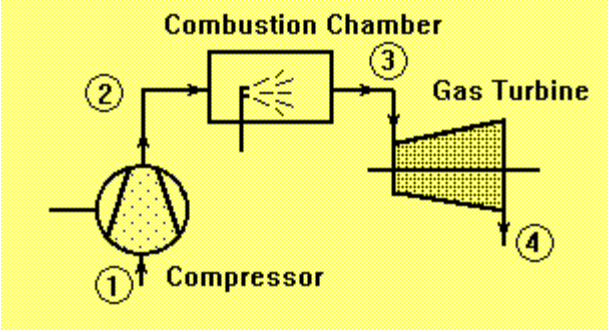
Because of this the lifting on most Hovercraft uses what is known as a centrifugal fan. This is a fan in which two discs are fitted together and looks rather like a doughnut with angled slat at their edges.

When the assembly is rotated at high speed air is sucked in to the center hole in the fan and the slats force it out at the edges. The advantages of the fan are two fold. They operate efficiently in an environment when back pressure is high and they will move larger volumes of air for a given rotation speed than a propeller with the same speed and power input

The lifting fan is coupled via a gearbox to the engine. The engine also drives the propeller on the craft, which provides thrust for forward motion of the Hovercraft.

# THE ENGINE

The engines used in Hovercraft have evolved like the skirt design. The SRN 1 and other early craft used piston type engines. As models like the SRN 4 and SRN 6 were brought into service they tended to favor the use of gas turbines. This type of engine is smaller and lighter for a given horsepower and has been used extensively in turbo prop aircraft.




The engine has a main shaft on which is mounted a compressor and turbine. A starter motor is connected to one end and the other end is connected to the lift fan. Both the compressor and turbine look like fans with large number of blades.

When the engine is started the compressor compresses air from the engine intakes and pushes into the combustion chambers mounted around the engine. Fuel is squirted into the combustion chamber and is ignited. The compressed air then rapidly expands as it is heated and forces its way out through the turbine to the exhaust. As the gas pressure raises the turbine speeds up, there by driving the compressor faster. The engine speed increases until it reaches engines normal operating speed.

However the use of these engines results in very high level of engine noise outside the craft. In the SRN6 this meant that it was possible to hear the craft traveling across the Solent between the Portsmouth and the isle of Wight in the UK several miles away. The current AP188 crafts that runs on the old SRN6 routes has now moved back towards the piston engines and uses marine diesel engines that are much quieter and fuel efficient.

# THE THRUST PROPELLER

The propeller used to drive the Hovercraft along is usually an aircraft type with variable pitch blades. Its speed of rotation must remain fixed to that the engine and the lift fan. This is because the amount of lift air requires dictates the engine speed to drive the lift fan. In turn the amount of propulsion which the propellers provide must be obtained by varying the propeller pitch and not its rate of rotation. This system is termed integrated lift. Hovercraft having more than one lift fan and propeller generally has a separate engine for each fan and propeller unit.

The propellers used on hovercraft can vary from four bladed versions and about nine feet in diameter on the smaller craft to the four propellers on the SRN4 cross-channel Hovercraft. These are four bladed and nineteen feet in diameter.

# RUDDERS AND CONTROL OF HOVERCRAFT

Control of a Hovercraft is accomplished by primarily though the use of rudders like the type used on aircraft. The main difference would be, however, that Hovercraft generally utilizes many rudders rather than just one.

On the SRN4 the pylons on which they are mounted can be rotated to change the direction of thrust. Another method of control is through 'puff ports' or dual thrust fans where you would slow one down and speed up the other to turn in the direction desired.

The hovercrafts are designed to float like a boat with the engine turned off. To stop the Hovercraft-Reducing engine RPM will reduce the air cushion height and increased drag between the skirt and the surface will slow and stop the Hovercraft. Alternatively, the Hovercraft can be turned 180 degrees and the engine accelerated till the craft stops. In an emergency situation on most surfaces turning the engine off will stop the Hovercraft immediately

# APPLICATIONS

As technology improves, performance improves and reduces noise levels; Hovercrafts are becoming increasingly popular as recreational machines. From cabins year round to cruising, fishing, driving and racing- the possibilities are endless. With the advantage of loading and unloading on land they are used for transporting people and equipment over water.

Hovercrafts are also used as warships to carry out rapid sea-lift and beach landing. They also provide fire support for troop on the shore. They are also capable of lying active minefields.

# FUTURE DEVELOPMENTS

By using the hover principle many designs have arise. One is the hover concept by replacing the cushion of low pressure air as inform the modern Hovercraft by high pressure pad it was thought that the pads of high pressure could replace the wheels of the car. but there are two difficulties.

1. It is difficult to lift
2. New method of propulsion is required

Then moved towards Hover train. Here rails provide smooth surface for high pressure air and guidance from the track overcomes the problem of steering.

# APPLICATIONS

- It will travel against a current of river with no reduction of speed
- A Hovercraft travel over the surface of water without concern for depth or hidden obstacles
- It can travel with great speed of up to 60 knots
- Hovercraft are unaffected by small waves and offer a comfortable smooth ride
- It is safe around swimmers as there are no propellers in water

- Many Hovercraft have sufficient hover height, ranging from 8 in to 18 in to pass right over a person in water
- The air cushion enables Hovercraft to operate over environmentally sensitive areas such as mudflats without disturbing the surface

- The lack of wake on water minimizes the potential for bank erosion
- It can load and unload peoples and equipments on land
- Unlike many boats, engine exhaust fumes are not directed into water and poisonous antifouling compounds are not required on Hovercraft

# CONCLUSION

The unique capabilities of Hovercrafts are recognized and appreciated by a diverse group of its end users. Hovercrafts are in use worldwide with search research groups, fire departments, airport emergency response units and scientific research teams. Hovercrafts are an integral part of numerous commercial operations including driving, tourism, water taxi, ferry service, ice breaking, goods delivery, survey, environmental monitoring and guide outfitting. The Hovercraft as a vehicle is still in common use but not in large volumes. As engine and materials technology progress the Hovercraft may yet make a comeback  but for now it is a special vehicle for special applications.

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