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IMPACT OF JET APPARTUS

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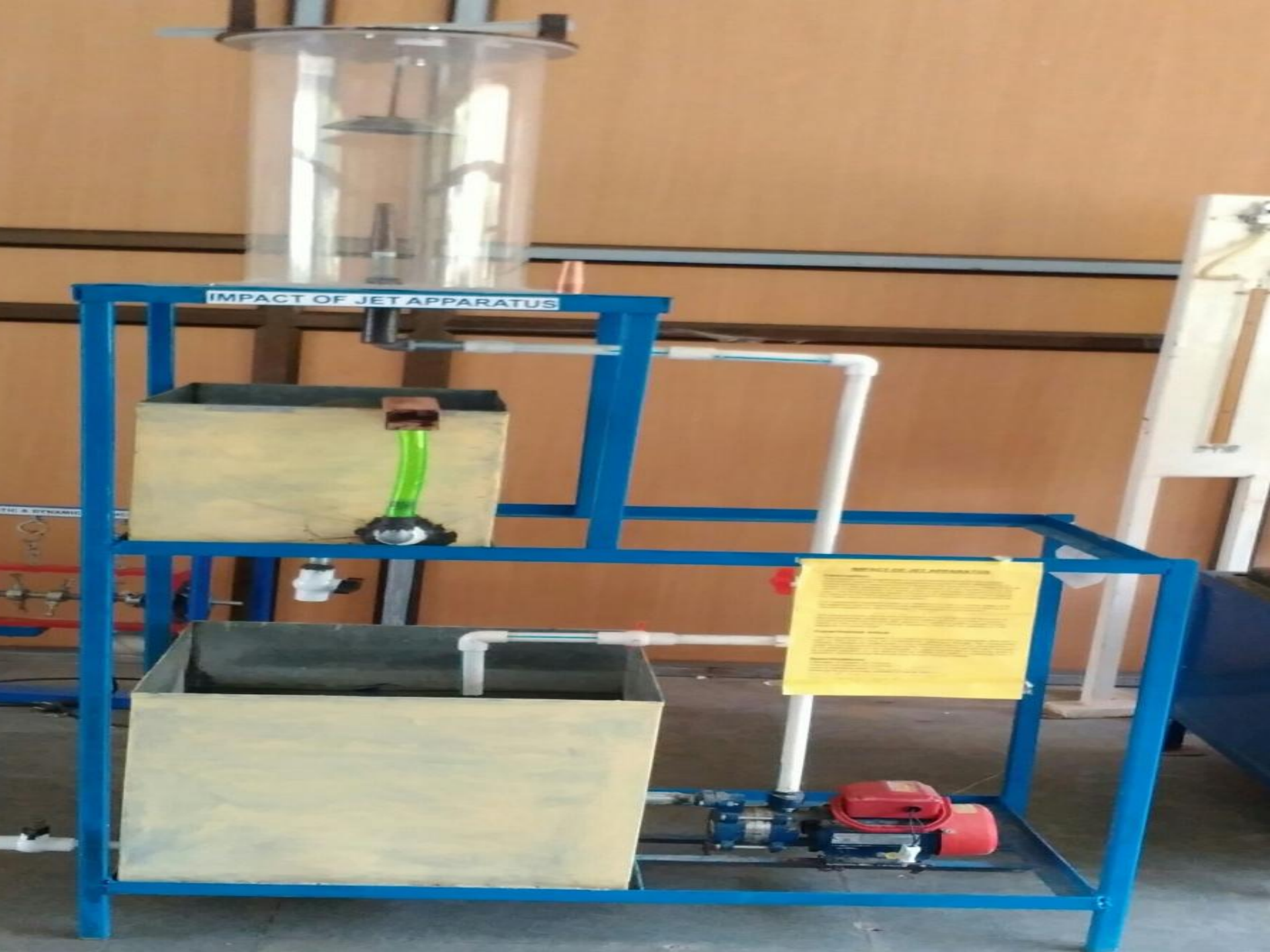
ENGINEERING COLLEGE

GROUP NO -35


IMPACT OF JET APPARATUS

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INTRODUCTION

- Impact of jets apparatus enables experiments to be carried out on the reaction force produced on vanes when a jet of water impacts on to the vane. The study of these reaction forces is an essential step in the subject of mechanics of fluids which can be applied to hydraulic machinery such as the Pelton wheel and the impulse turbine.

- when the fluid coming from nozzle strikes on surface (i.e. plate, vane), it is experiences some force. According to Newton's second law of motion, This force is equal to the rate of the fluid stream.

- **Definition**:-
  - ❖ Jet:-“The fluid stream coming from nozzle with high velocity and hence a kinetic energy is known as fluid jet”
  - ❖ Impact of jet:-the force exerted by fluid jet on a plate is known as impact of jet
- As we know Newton's second law of motion “The rate of change of momentum is directly proportional to the impressed force and takes place in the same direction in which the force acts”

➢ Mathematically,

:.F=d/dt (m*v) (m.V=momentum)

:.F=m(dv/dt) (m=constant)

:.F=ma

❖OBJECTIVE:-

- To investigate the reaction force produced by the impact of a jet of water on to various target vanes.

LITERATURE REVIEW

PAPER NO.	TITLE	EXPERIMENTAL RESULT
Paper 1:-	**Pelton Turbine Experiment**	• Turbines convert fluid energy into rotational mechanical energy. The primary feature of the impulse turbine is the power production as the jet is deflected by the moving buckets. • When the fluid passing throw nozzle then there was the pressure energy of nozzle is converted into kinetic energy
Paper 2:-	**The effect of Nozzle design on the stability and performance of turbulent water jets**	• Measurements of the stability of water jets discharging into air are presented for jets from nominal 12.7 mm diameter nozzles having various internal profiles and contraction angles. • For straight-sided profiles, one which approached the axis at 30° formed the best all round jet of a series of profiles in which this approach angle was varied in increments of 15°.

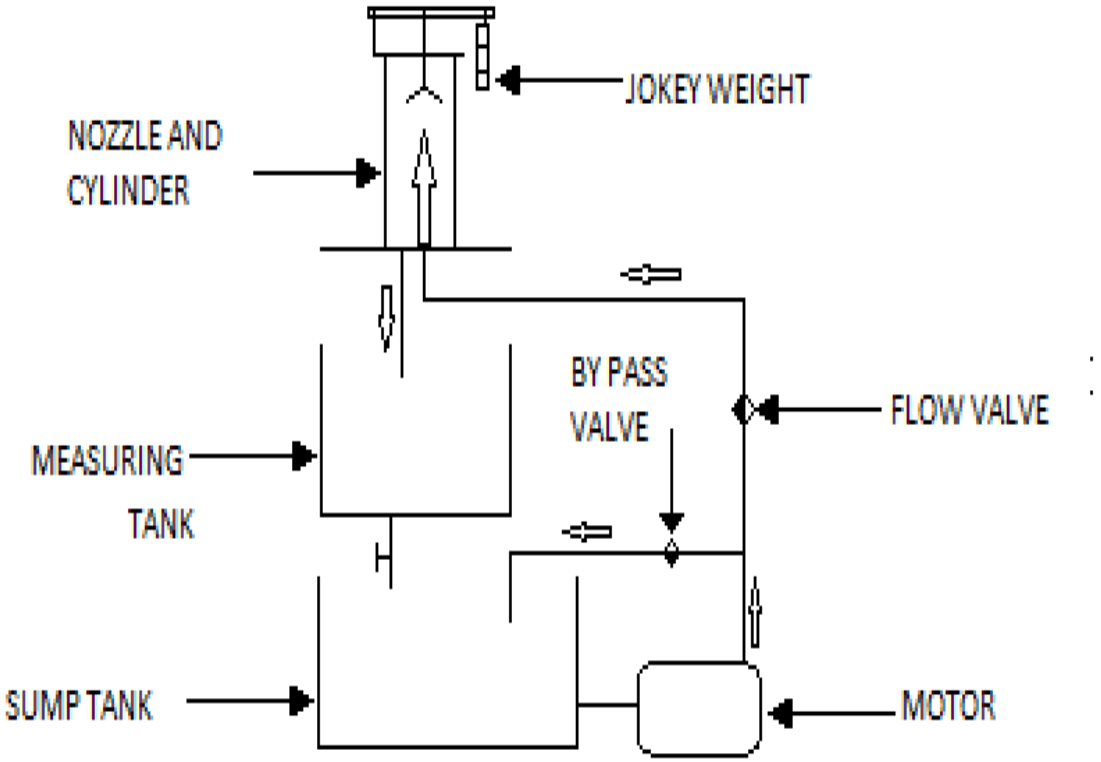
PAPER NO.	TITLE	EXPERIMENTAL RESULT
Paper 3:-	**Cleaning of a model food soil from horizontal plate by a moving vertical water jet**	• The removal of layers of a model food soil by a vertical water jet impinging normally on to the plate, generated by a solid stream nozzle which moves across. Their experiments investigated nozzle pressures from 0.5 to 2.0 bars, nozzle diameters from 0.84–2.66 mm, nozzle-layer separation of 20 mm, and nozzle traverse speeds of 2.1–126 mms^{-1}.
Paper 4:-	**Micro machining with continuous electrolytic free jet**	• Electrochemical machining is a potential procedure for high precision micro manufacturing. specially the machining of metallic work pieces without any thermal or mechanical impact and the independence from the material's hardness are significant features. In this study, a special procedure for the fabrication of complex micro geometries and microstructure surfaces is investigated. This will be done by help of a continuous electrolytic free jet ECM.

PAPER NO.	TITLE	EXPERIMENTAL RESULT
Paper 5:-	**Experimental study of non-boiling heat transfer from a horizontal surface by water sprays**	• The results of an experimental study on non-boiling heat transfer from a horizontal surface by a pressure atomized water spray are presented here. A vertical circular copper cylinder was electrically heated from below; its top surface was spray cooled and sides were insulated. The target surface diameter was 20 mm.
Paper 6:-	**A review of abrasive jet machining**	• Abrasive jet machining is one of the unconventional machining processes which, using various operations such as debarring, polishing, cutting etc., can be carried out effectively and efficiently, to close tolerances. In this paper, a comprehensive review of work done in this field is given and complex analytical findings that have been made are highlighted.

❖Scope of project:-

- 1) applicable at turbine.
- 2) applicable at hydraulic power plant.
- 3) for laboratory purpose.
- 4) for cutting operation.

❖DESIGN OF PROPOSED SYSTEM




COMPONENT

1. SUMP TANK

DIMENSION: 450*450*450(mm)

Function:-

It is a tank in which water is being collected after the whole procedure as well as starting of water to pick from pump takes place.

2. MEASURING TANK

Dimension:450*300*300(mm)

Function:-

It is helpful for measuring discharge while the water return after jet strikes to vane.

3. FRAME

Function:

It is simple construction on which the parts like sump tank, measuring tank, pump, cylinder and nozzle is fitted.

4. PUMP

Specification:
P=0.37kw
P=0.5hp
Size=15*15(mm)
I=2.5amp
N=2700rpm

Working:

A pump is a device that moves fluids, or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: *direct lift*, *displacement*, and *gravity* pumps. Here, pump is collecting water from sump tank and send to the nozzle where water strikes on vane.

5. VALVES :

Diameter: 20 mm

Function:

It is manual operating device for halting or controlling the flow of a liquid, gas, or other material through passage, pipe, inlet, outlet, etc

6. CYLINDER(TRANSPARENT)

Specification:
L=450mm
D=270mm

7. NOZZLE

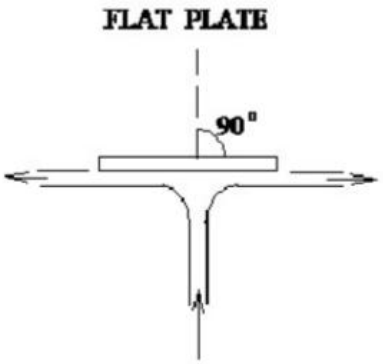
Dimension:

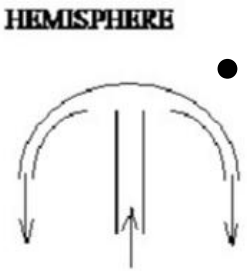
1. Inlet dia=15mm
   Outlet dia=8mm

2. Inlet dia=15mm
   Outlet dia=6mm

A nozzle is a device designed to control the direction or characteristics of a fluid flow as it exits an enclosed chamber or pipe

8. VANES





- For the Flat plate:

  $F = \rho Q V_{in}$

- For the Hemi spherical cup:

  $F = 2 \rho Q V_{in}$

9. JOKEY WEIGHT:-

It is the additional weight to be tilted on rod for maintaining the stability.

❖EXPERIMENTAL SETUP

➢ Working:-

- When a jet of water flowing with a steady velocity strikes a solid surface the water is deflected to flow along the surface. If friction is neglected by assuming an in viscous fluid and it is also assumed that there are no losses due to shocks then the magnitude of the water velocity is unchanged. The pressure exerted by the water on the solid surface will everywhere be at right angles to the surface. Consider a jet of water which impacts on to a target surface causing the direction of the jet to be changed through an angle as shown in figure . In the absence of friction the magnitude of the velocity across the surface is equal to the incident velocity Vi. The impulse force exerted on the target will be equal and opposite to the force which acts on the water to impart the change in direction.

APPARRTUS

- This apparatus is designed primarily for use on the Hydraulics Bench. By directly measuring the force exerted on the plates by the water jet, it allows the student to experimentally study the theoretical momentum laws used to solve jet impact problems.
- An upper weigh beam is pivoted on precision bearings at one end and carries along its length the fixed test plate. The beam jockey and a scale are used to measure the jet force. An adjustable spring supports the lever and is used for setting the initial zero level of the beam. A hanging tally weight on the end of the beam is used to return the beam to horizontal each time a reading is required.
- A high velocity jet is produced by the vertical tapered nozzle. For clear observation, both nozzle and test plate are contained in a transparent cylinder.
- The apparatus is leveled for test using the plastic screwed ball feet provided on the base legs.

PROCEDURE:

1. Position the weight carrier on the weight platform and add weights until the top of the target is clear of the stop and the weight platform is floating in mid position. Move the pointer so that it is aligned with the weight platform. Record the value of weights on the weight carrier.
2. Start the pump and establish the water flow by steadily opening the bench regulating valve until it is fully open.
3. The hemispherical vane will now be deflected by the impact of the jet. Place additional weights onto the weight carrier until the weight platform is again floating in mid position. Measure the flow rate and record the result on the test sheet, together with the corresponding value of weight on the tray. Observe the form of the deflected jet and note its shape.
4. Reduce the weight on the weight carrier in steps and maintain balance of the weight platform by regulating the flow rate in about three steps, each time recording the value of the flow rate and weights on the weight carrier.

5. Close the control valve and switch off the pump. Allow the apparatus to drain.
6. Replace the 8mm nozzle with the 6mm diameter nozzle and repeat the tests.

❖CALCULATION

- In order to calculate the force caused by impact of a jet into a flat plate or curved vane, the change in momentum principle is applied;

$$\text{Force} = \text{Rate of change in momentum}$$

$$F = \rho Q V_{in}$$

Where;

F: the force exerted by the jet on the plate.

ρ: the mass density of water (= 1000 kg/m3).

Q: volumetric rate of flow (m3 /s).

ΔV: the change in velocity just after and before impact.

- The volumetric flow rate in the equation 'Q' is calculated in the experiment by taking an amount of volume in a known period of time and then use;

$$Q = v / t$$

•Vin is calculated in the experiment by first knowing the velocity at the nozzle and then using the motion equations.

- Vnozzel is measured by know the diameter of the nozzle (dia = 8mm) and the volumetric flow rate 'Q' calculated previously,

$$V_{nozzle} = Q / A$$

- Then Vin is calculated by;

$$V_{in}^2 = V_{nozzel}^2 - 2gS$$

Where;

g: the gravitational acceleration (9.81 m/s2).

S: the distance between the jet and the plates (35mm)

- Vout generally equals Vin cos θ, where θ represents the change in direction of the jet. For the flat plat $\theta = 90^\circ$,

- so that Vout = 0.0 .

- For the Hemispherical cup $\theta = 180^\circ$,

- so that Vout = -Vin So the following relations are used for calculating the Predicted values of the force;

  For the Flat plate: $F = \rho Q V_{in}$

  For the Hemi spherical cup: $F = 2 \rho Q V_{in}$

- The measured force from the experiment is calculated by using the equilibrium of moment equation. And the final relation for calculating the measured force is:-

$$F = m^* g$$

RESULTS

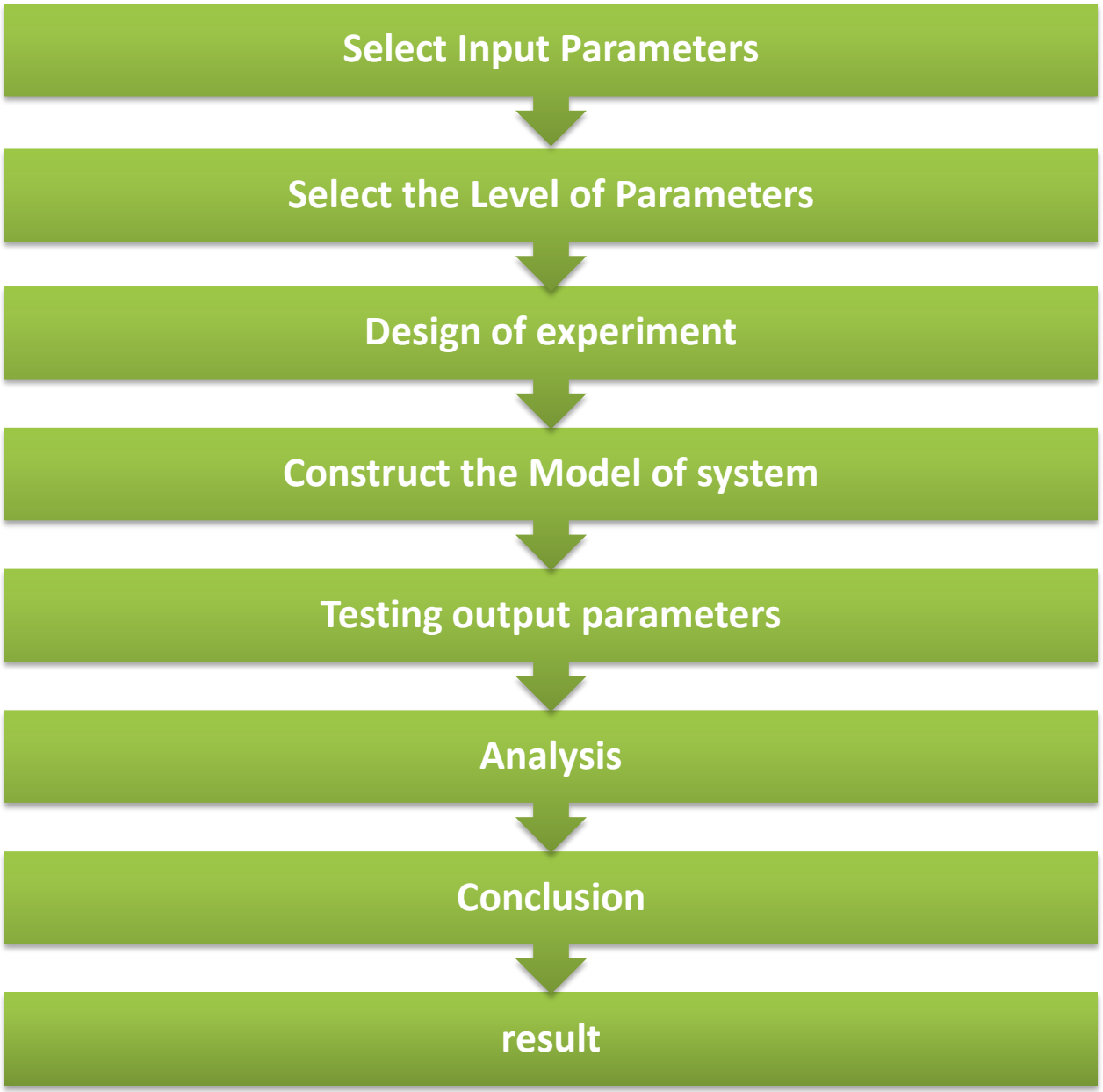
Data Hemispherical cup

Volume (liters)	Time (seconds)	Q (m3 /s) * 10 – 4	Vnozzel (m/s)	Vin (m/s)	F1 Predicted (N)	F2’	F2 Measured (N)	error
6	12.03	4.99	6.05	5.99	5.97	2.52	5.45	0.53
5	10.4	4.81	6.13	6.07	5.84	2.43	4.51	0.46
4	9.6	4.17	5.31	5.24	4.37	1.82	3.73	0.51
5	13.65	3.66	4.66	4.59	3.36	1.4	2.75	0.49
5	17.36	2.88	3.67	3.58	2.06	0.85	1.73	0.50
4	19.10	2.09	2.66	2.53	1.06	0.44	0.86	0.47

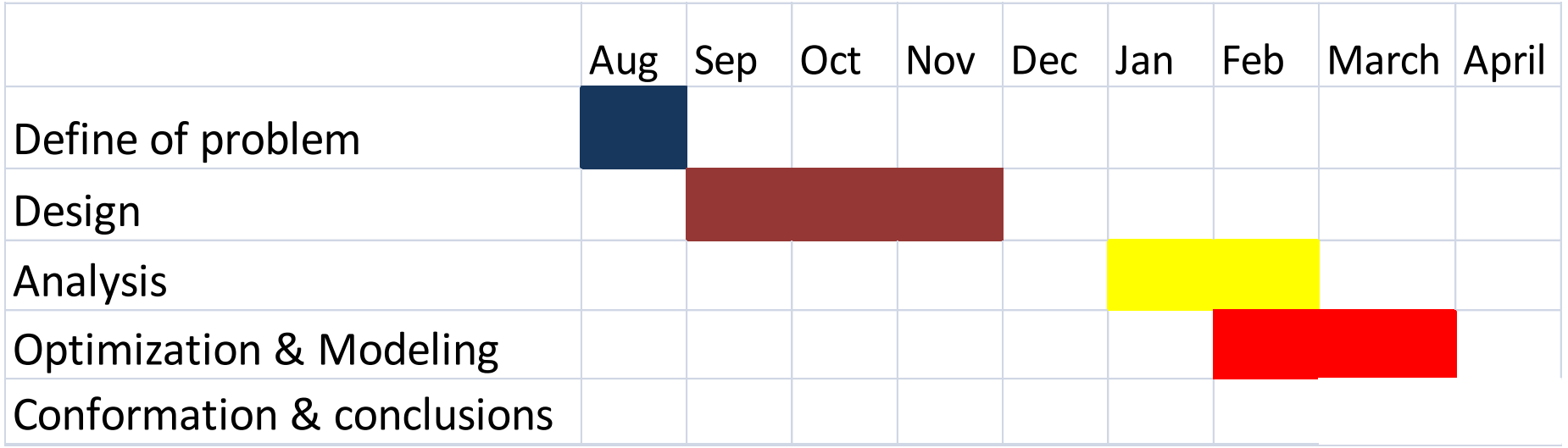
❖ Conclusion:-

- As a conclusion, the calculated force is correlated with the measured force. Both of the forces will have directly proportional relation. Theoretically, the calculated force should be the same as the measured force. However, this cannot be achieved experimentally due to the errors made during the experiment. Form this experiment, the flow rate for the hemisphere is found to be the lowest and thus require a longer time for the volumetric tank to rise from 20 to 30 litres.

❖Methodology



❖ Work Plan


Aug
Sep
Oct
Nov
Dec
Jan
Feb
March
April
Define of problem
Design
Analysis
Optimization & Modeling
Conformation & conclusions

The Business Model Canvas

Impact Of Jet Apparatus

Design by: (1)Patel Utkarsh
(2)Patel Adarsh
(3)Raval Nishant
(4)Prajapati Sunil

Date:5/4/2016

No.:35

Key Partners

Industries

University

National laboratory

Key Activities

Market products

Team manaement

Sponcer

Key Resources

Mechanical workshop

autocad

Value Propositions

Quantitative

Qualitative

Customer Relationships

Research centers

Automated Services

Innovation

production manager

Channels

Water jet based industries

Customer Segments

Turbine manufacturers

Cost Structure

Economies of Scale

Fixed Costs

Revenue Streams

Advertising

Lending/ Leasing/ Renting

❖REFERENCES

1. TecQuipment Ltd, Bonsall Street, Long Eaton, Nottingham NG10 2AN, UK
2. Nasr, Yule and Bending, "Industrial Sprays and Atomization", Springer, 2002, ISBN 1-85233-611-0
3. Lipp, C.W., Sprays Article, Kirk-Othmer Encyclopedia of Chemical Technology 5th Ed 2005
4. W.R. Marshall Jr. Atomization and Spray Drying, Am. Inst of Chem Engr. Monograph Series, 1954
5. J. U. Bete, water jet , US Patent 2,804,341, 1956
6. *"Lechler spray nozzles and engineered systems". www.lechler.com. Retrieved 2016-03-21.*
7. Pagcatipunan, C., Schick, R., Maximize the Performance of Spray Nozzle Systems in turbine, Chem. Engr. Progr., December 2005.
8. *Berger, Harvey. "Director of Technology". NCBI.*
9. Lefebvre, Arthur, *Atomization and Sprays*, Hemisphere, 1989, ISBN 0-89116-603-3
10. Franz, Norman C., High Velocity Liquid Jet, filed May 31, 1968, and issued August 18, 1970.
11. Olsen, John H., High Pressure Fluid Intensifier and Method, filed March 16, 1976, and issued June 14, 1977.

Thank you...