AZEOTROPY 2019

Pump-It Problem Statement

Deadline for abstract submission – 11:59 pm, 30th January, 2019

INTRODUCTION

Pump plays an important part in supplying energy to transport, or compress fluids. They are the most significant accessory used in the chemical industry. There are multiple types of pumps namely centrifugal pump, diaphragm pump, piston pump and so on. Centrifugal pumps are the primary group types in the class of pumps called as "kinetic" pumps. The main parts of the centrifugal pump are the impeller, which is used to increase the kinetic energy of the flow and shaft (motor) onto which the impeller is mounted. Valves are used in association with a pump for flow regulation.

Flowing water has multitude of uses. One of those predominant applications of running water is **hydroelectricity**. Pump-It is the amalgamation of these. Pump-It encourages you to bring out your competitive spirit and get your mind working on a challenging model making competition, wherein you get to drive the fluid and manipulate its properties to generate electricity.

AIM

You have to come up with an **electrically powered model** of a centrifugal pump designed to transport the fluid (water) through a given hydraulic network and manipulate the flow parameters to **generate electricity**. The objective of this competition is to give students a better understanding of the working of a centrifugal pump, flow regulation and use this knowledge to generate hydroelectricity.

The key objectives are

- Engineer a centrifugal pump
- Pump the fluid up to certain height

- Manipulate the flow variables to generate hydroelectricity by making turbine **on your own**

Participants need to set the following parameters to get the desired flow rate and electric current.

- Impeller diameter
- Height of fall of water from the container to get desired hydroelectric current and voltage.
- Diameter of the outlet pipe from container
- Height of the support
- Diameter of the water turbine

The model should also pump the fluid to the desired height into a container. The outlet of the container should be positioned so as the falling water from the container must be able to generate the desired amount of electricity.

MODEL

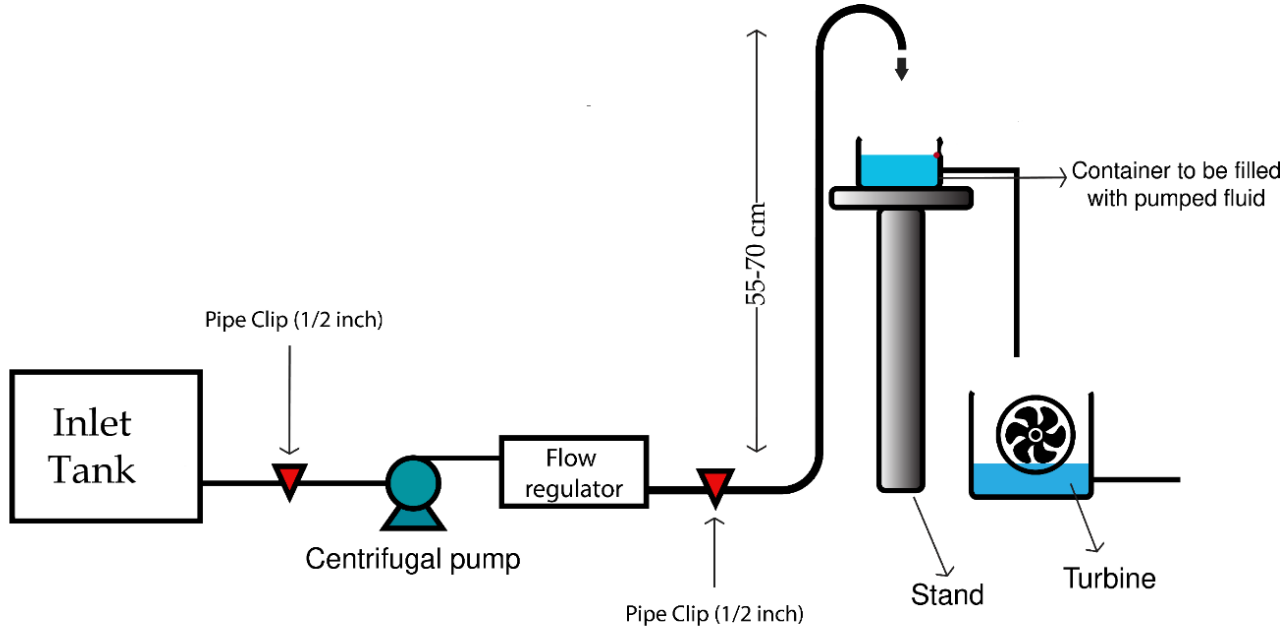
Components:-

- The **impeller diameter** of the Centrifugal pump (has to be built from scratch) must be less than **12 cm**.
- A section incorporating a motor, a battery (V volts) and a switch to operate the battery.

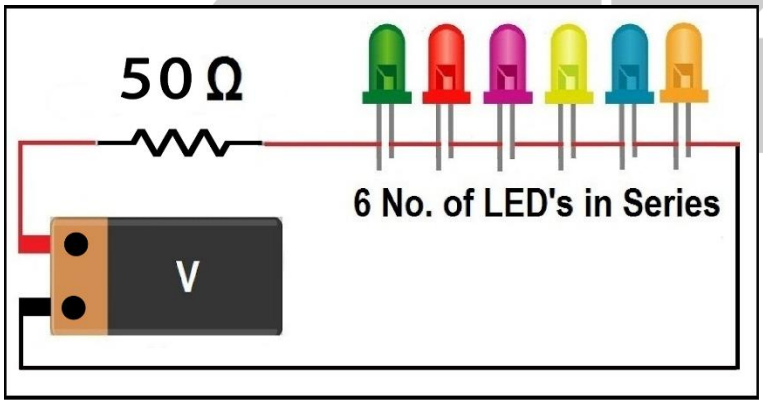
  Note: No electric supply will be provided.

- **Valves** or **any mechanical** (non-electronic) **pressure drop mechanism** by which flow rate can be regulated (valves must be designed and manufactured on your own).(Compulsory: The reasoning of mathematical values like the angle at which the valve is positioned and other parameters need to be stated on the day of competition as well as in the abstract with proper measurements or experimental data)
- A container (preferably transparent) with an outlet positioned at a particular position (to be decided by the participants).
- A **hydropower generator** consisting of an impulse turbine, a generator (or dynamo) to convert mechanical energy to electrical energy and an electrical circuit of LEDs (provided by us) to observe the output of your generator.

Flow Diagram:



Electric Circuit:



Note: LEDs are of 1.3V, 10 mA rating. There can be relevant changes in this.

The electrical circuit consisting of arrangements of LEDs and resistors (as shown) will be used to test your output of the hydroelectric generator. Your aim is to make all the LEDs glow using the sufficient amount of voltage and current produced by hydropower generator. Parameters like the diameter of the impeller, the height of the support pipe, and position of the outlet

from the container have to be decided by the participants in order to get the output of the circuit.

Pipe clips must be used to connect pipes. All pipe clips shown in the diagram must be detachable on the event day. Only the water-filled inlet tank, the stand and a tub for keeping hydroelectric generator will be provided during the actual competition.

JUDGING CRITERIA

A) Construction and performance of the model

Task 1: Crossing the threshold volumetric flow rate of 1 litre/min (without flow regulation) - 10 %

Hint: Set the voltage parameter such that it comes in that range.

Task 2: Attaining a fixed volumetric flow rate with flow regulation on -15%

Flow regulation percentage will be mentioned on the event day.

Example. If the initial flow rate with no flow regulation is X and flow regulation percentage is 40%, participants need to bring the flow rate from X to 0.6X.

Performance = 15 * (Achieved flow rate / Desired Flow Rate)

Task 3: Pumping water to a specific height (range of 55-70 cm) - 10%

Note: The height should be in **multiples of 5** for example 60 or 65, preferably not in between them.

Task 4: 1. Working of the turbine **- 10 %**

2. Getting correct output of the test electrical circuit provided - **10 %**
3. The efficiency of the hydropower generator- **15 %**

(Formula used: Power = efficiency * g * flow rate* height of fall)

Performance = (15)*(calculated efficiency)/(0.8)

B) Innovativeness of the flow regulation mechanism – 10%

● The participants will be graded on how creative their flow regulation technique is.

A creative model is the one which uses a non- conventional approach to get the output.

C) Judge Overview – 20%

● The participants will be questioned about the working and the fundamental concepts involved in their model

SPECIFICATIONS

1. The outlet diameter of the pipe after the flow regulator must be of **1/2 inch.**

2. The inlet pipe must fit into all pipe clips of **1/2 inch.**

3. The outlet diameter of the pipe from the container needs to be decided based on the flow rate required to run the turbine and get sufficient current and voltage.

4. The **diameter** of the water turbine must not be more than **20 cm**.

5. You are advised to use water driven **DC generator dynamo of 12V 6W**.

SIZE AND COST CONTRAINTS

1. The overall (assembled) size of the model presented on the event day should not exceed **800mm * 300mm * 1500mm** (except turbine and generator).

2. The centrifugal pump size should not exceed **150mm * 150mm * 50mm**. (a * b * c where a is the length, b is the width and c is the thickness or height)

3. The impeller diameter must be smaller than **12cm.**

4. The diameter of the water turbine must **not** be **more than 20 cm.**

5. Cost of the model should not exceed INR **4,000** (also include cost sheet in your abstract).

TEAM SPECIFICATIONS

1. Each team may consist of a maximum of **4 participants**.

2. Students of different institutions can also form a team.

3. Participants can be from different departments of which at **least one member** should be majoring in Chemical Engineering.

4. Teams should first register for Pump-It and get a unique Team ID exclusive for Pump-It competition.

5. **No participant** can register for more than one team. In this instance, both the teams will be subject to disqualification.

SAFETY MEASURES AND INSTRUCTION

1. Participants are required to carry their own safety equipment like **gloves, M-seal and masks.**

2. The entry must leave no residue on the table or the surrounding area.

3. Participants are not required to construct an inlet water storage tank in the model. They may carry a water container just for the experimental purpose on the event day.

STRUCTURE OF THE COMPETITION

A) Registration

● Register for Pump-It at: https://azeotropy.org/2019/competitions/pumpit

● After successful registration, each team will be allotted a unique Team ID which would be used for all further correspondences.

B) Abstract Screening

It is mandatory for each team to submit an abstract of your model and progress made until then to be eligible for participation on the event day. It serves as a brief description of the model prototype. Based on abstract submissions, teams will be shortlisted for the event day competition. A mail regarding your selection will be sent to you.

Write an abstract with a detailed description of your model (word limit 1000, file size not exceeding 1.5 MB).

The abstract should contain the following details:

- **Name** and **contact information** of the members and Team ID for Pump-It
- Properly **labelled diagram** specifying all the components in the model
- **Specification** of the components to be used in the model

A short explanation of

- How the centrifugal pump was constructed
- Functioning and the calibration of flow regulating mechanism

- Working of the turbine, how the flow parameters are set to get the desired current and voltage.
- The amount of each material and component used
- Calculation of rpm required for getting required voltage and current using dynamo
- Cost analysis estimate of each material to be used for the model

NOTE:

a) Attaching images of your model is a plus for getting shortlisted though not compulsory. You are not expected to complete the practical aspect of the model in the first stage.

b) Upload your abstracts in PDF format only with the file name as: **'PumpIt_<TEAMID>.pdf'**.

c) The decision regarding the selection of abstracts rests with Team AZeotropy, IIT Bombay. No further correspondence shall be entertained in this regard.

C) Final Round on Event Day

The winners of the competition will be decided on the basis of results from Stage 1 (i.e. abstract selection), and the model presented on the event day and its performance. The teams will be asked to give a brief overview of their model to the judges. Based on their understanding and the performance of the model, they will be graded.

GENERAL RULES

1. The abstract should contain the original work of the participants and must not be plagiarized.

2. Modified abstracts can be uploaded to the portal again, but the final abstract submitted before **11:59 pm, 30th January 2019** will only be considered. Your Pump-It model should be built based on the final abstract submitted.

3. The problem statement on the website on the abstract submission deadline will be considered for all evaluations.

4. Any changes in the problem statement and updates regarding the competition will be notified to the registered participants through emails.

5. Submission of similar abstracts by teams from the same institution or falsifying information in the abstracts shall lead to immediate disqualification.

6. The decision regarding final selection of the team rests with team AZeotropy 2019.

7. No second attempts will be allowed for any team on the event day.

8. The judging criteria and specifications are subject to changes until the event day. Team AZeotropy holds all the right to do the same.

9. Final decision-making authority lies with Team AZeotropy, IIT Bombay

CERTIFICATE POLICY

1**. Top 3 teams** will be awarded **Certificates and Cash Prizes**.

2. **Certificates and Cash prizes** will also be awarded to a team with **'Best Innovative Model'** (apart from top 3 teams).

3. **Certificate of Participation** will be given to all qualified teams performing on the event day.

CONTACT

For any queries related to the Problem Statement or Registration, participants can contact:

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