Axial and mixed flow pumps (Mechanics)

One-day training

Session 1 – Introduction, training objectives and pre-training evaluation
What do you expect to learn from this training?

- In groups, discuss what you think you’ll learn today.
- Choose one of the participants to speak for the group.
- Take Notes.
Today’s sessions

1. Introduction, training objectives and pre-training evaluation
2. Introduction to the axial flow pump and mixed flow pump
3. Major parts of the axial and mixed flow pumps
4. Common causes of axial and mixed flow pump failure and breakdown and their potential solutions
Today’s sessions

5. Common causes of axial and mixed flow pump failure and breakdown – practical troubleshooting

6. Review of key messages, post-training evaluation and close of training
What kind of training is this?

This is participatory training, so:

• Ask questions and speak.

• Learn by experience – run irrigation pumps yourself and learn how to operate them.

• Learn by discussing each topic with your group.
• **Speak up when the facilitator asks questions — and ask questions yourself.** This way we can learn from each other.

• **Feel free to ask questions and to contribute your knowledge!**
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- Make sure you get time to practice how to set up and operate the pump.
- Have fun!

Please enjoy this training!
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Session 2 – Introduction to the axial flow pump and mixed flow pump

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What is an axial flow pump?

- An axial flow pump (AFP) is a pump driven by

  1. a shaft encased in a long pipe, and

  2. an impeller (this is a reverse directed propeller – like on a boat – which is powered by a diesel engine or electric motor).
• A mixed flow pump has a ‘bell’ at the end, where water is sucked into the pump. The impeller is usually larger than the diameter of the conduit pipe in which the shaft is encased.

• Axial and mixed flow pumps were developed by innovative farmers in Vietnam and Thailand in the 1960s and are now common throughout Southeast Asia.
• Both pumps are known as ‘propeller pumps’ – because the impeller works much like a boat propeller.

• To run either an axial or mixed flow pump, a two-wheeled tractor or a diesel engine of 12-16 HP is usually necessary, unless engines are directly coupled. However, these are rare in South Asia.
• Using these pumps to irrigate farmers’ fields can be profitable – for the pump owner and for the farmer too!
### Differences between the AFP/MFP and the centrifugal pump

<table>
<thead>
<tr>
<th>Criteria</th>
<th>AFP/MFP</th>
<th>Centrifugal pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Frictional loss</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Operating cost</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Power transmission</td>
<td>high efficiency</td>
<td>low efficiency</td>
</tr>
<tr>
<td>Operating time required</td>
<td>less</td>
<td>more</td>
</tr>
<tr>
<td>Manufacture</td>
<td>easy to fabricate</td>
<td>difficult to fabricate</td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Water lifting height</td>
<td>up to about 3 m (and fuel efficient)</td>
<td>over 3 m (but with low fuel efficiency when lift &lt; 3m)</td>
</tr>
</tbody>
</table>
Advantages of the AFP

Early experiments show that:

- At 1 m lift, the AFP is 51% more fuel efficient than the centrifugal pump.
• At 2 m lift, the AFP is 21% more fuel efficient than the centrifugal pump.

• At 3 m lift, the AFP discharges more water but the fuel cost is higher.
Mixed flow pumps can provide increased lift height. Experiments are under way to determine the best engineering approach to developing highly fuel efficient MFPs.
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Session 3 – Major parts of the axial or mixed flow pump and their functions
Major parts of the axial flow pump and their functions

1. Pipe column
2. Bearing house mount
3. Bearing housing
4. Inlet side drive shaft
5. Thrust bearing
6. Ball bearing
7. Additional ball bearing
8. Shaft collar
9. Mounted bearing
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10. Inlet screen
11. Impeller
12. Suction end bushing
13. Suction end stator
14. Suction bell
The inlet screen

Prevents dirt and other stray materials from getting into the pump from the canal, pond or river that the water is pumped from.
The impeller

Pumps/pushes water upward through the pipe or conduit.
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The suction end stator

Straightens water flow and reduces turbulence.
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The driving shaft
Drives the impeller

The bearing housing
Holds the bearings
The pipe/conduit

Transfers the water pumped by the impeller until delivery.

Note: this pump is an AFP (not MFP) because it does not have a ‘bell’ shape at the end of the pump from where water is drawn.
The bushing

Holds the impeller and shaft in place
The pulley

Drives the shaft to rotate the impeller (powered by an engine)
The diffuser vane

Straightens the water after it is transferred by the impeller into the conduit pipe.
Review of Key messages

• The axial pump and the mixed flow pump are very similar.

• Axial flow pumps have smaller impellers – these fits inside the conduit pipe.

• The mixed flow pumps has larger which is wider than the conduit pipe. It delivers more water than an axial flow pump.
## Axial and mixed flow pumps (Mechanics)

<table>
<thead>
<tr>
<th>Name of part</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet screen</td>
<td>Blocks dirt and other stray materials from getting into the pump from the canal, pond or river where water is pumped from</td>
</tr>
<tr>
<td>Impeller</td>
<td>Pumps/pushes water upward through the pipe or conduit</td>
</tr>
<tr>
<td>Driving shaft</td>
<td>Drives the impeller, which pushes water up the pump</td>
</tr>
<tr>
<td>Pipe or conduit</td>
<td>Holds the water pumped by the impeller until delivery</td>
</tr>
<tr>
<td>Bearing housing</td>
<td>Hold the bearings</td>
</tr>
<tr>
<td>Bushing</td>
<td>Works like a bearing and holds the shaft in place</td>
</tr>
<tr>
<td>Pulley</td>
<td>Drives the shaft (powered from an engine)</td>
</tr>
<tr>
<td>Diffuser vane</td>
<td>Straighten the water flow and reduces turbulence</td>
</tr>
</tbody>
</table>
Session 4 – Common causes of failure and breakdown of the axial flow pump and mixed flow pump (potential solutions)
Problem 1: the pump shaft breaks

Symptoms:
Abnormal sounds from the pump or no water discharge
Causes:
(1) over-running the pump
(2) excessively high water lift height
(3) faulty shaft

Effects:
Complete pump failure (meaning that the pump cannot be used)
Spare parts required:
Shaft

Where to get or make/repair spare parts:
collect new one from a dealer or make another one with a new pipe

Tools required:
dual wrench, adjustable wrench, screwdriver, hammer and puller
Problem 2: water leakage during pumping due to faulty oil seal

Symptoms:
Water leakage from the base of oil seal
Cause(s):
(1) tearing or loosening of the oil seal
(2) loosening of nuts and bolts
(3) bent shaft

Effects:
(1) water gets into the bearing and causes bearing damage
(2) reduction of water discharge/efficiency
(3) increased fuel cost
Solution:
(1) straighten the shaft
(2) replace oil seal
(3) tighten nut-bolts
(4) replace bearing support
(5) replace faulty bearings

Spare parts required:
- oil seal, bearings

Where to get spare parts:
- shop deals with pump/engine spare parts

Tools required:
- dual wrench,
- adjustable wrench,
- screwdriver
Problem 3: the transmission V-belt rips

Symptoms:
The v-belt connecting the engine to the pump cracks or tears
Causes:
(1) misalignment of the engine and pump and pulleys
(2) engine speed too high
(3) the pump pulley is too close to the engine
(4) the surface of the pulley is rough, wearing away the belt
(5) the V-belt is old
Effects:
(1) belt slippage
(2) reduction of discharge
(3) increase of cost
(4) the pump fails

Prevention:
(1) align the pulley correctly in a straight line with the pump
(2) use a large belt if water level is too low
(3) file the pulley until smooth
Solution: replace the belt (full set)

Spare parts required: V-belt

Where to get spare part: shop dealing in pump/engine spare parts

Tools required: file or sand/glass paper
Problem 4: pump impeller breaks

Symptoms:
Low discharge of water, abnormal vibration of the pump, lack of water flow
Cause:
Foreign objects or dirt are sucked into the pump, breaking the blades or causing their disruption

Effects:
(1) reduced discharge due to partial break of blade(s)
(2) zero discharge due to complete break of blade(s)
Solution:
(1) repair the blade(s), and/or
(2) replace the impeller

Spare parts required:
Impeller
Where to get or make/repair spare parts:
purchase new impeller from dealer or repair/have new blade(s) prepared at a local workshop

Tools required:
dual wrench and adjustable wrench
Problem 5: pump pulley worn out

Symptoms:
these can be felt by touching the pulley – it will be out of shape, or show gouges or similar defects.
Causes:
(1) loose V-belt
(2) rough surface of pump pulley

Effects:
the V-belt tears

Spare parts required:
new V-belt, or new pulley (if the deterioration of the pulley is severe)

Where to get spare parts:
at a shop dealing in pump/engine spare parts
Tools required:
file or sand/glass paper, wrenches
Problem 6: damage to shaft bushing due to deposition of sand in the pump

Symptoms:
excessive vibration of the pump, faulty shaft
Causes:
(1) the impeller is too close (less than 0.6 m) to the bottom of the canal, pond or river, and/or
(2) running the pump in muddy or sandy water

Effects:
(1) the shaft bends/breaks, and/or
(2) bushing rips
Prevention:

(1) always place the impeller at least 0.2 m (or never less than 0.3 m) above the bottom of the water body you are pumping from

(2) never run the pump in muddy or sandy water

Spare parts required:
bushing
Where to get or make/repair spare parts:
purchase new one from dealer or repair/have a new one made at a local workshop

Tools required:
dual wrench, adjustable wrench
Problem 7: shaft bearing(s) fail

Symptoms:
Noise, overheating bearing (s)
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Causes:
(1) misalignment of the shaft
(2) old bearing(s)

Effects:
(1) power loss
(2) reduction in discharge

Solution:
Replace faulty bearing(s)
Spare parts required: bearing(s)
Where to get spare parts:
at a shop dealing with pump/engine spare parts

Tools required:
dual wrench, adjustable wrench, screw driver, hammer, puller and chisel
Problem 7: shaft bearing(s) fail

Symptom:
black smoke comes from the engine during operation
Causes:

(1) engine speed is too high

(2) water lift height is too high

(3) engine size/horse power is too small for the AFP/MFP being used

(4) engine is old or overloaded
Effect:
damage can be caused to the engine

Solution:
(1) reduce engine speed
(2) pump water within the suggested range of water lift heights
(3) select correct engine or pump
Review of key messages, post-training evaluation and close of training
Axial and mixed flow pumps

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• What are major parts of an axial or mixed flow pump and their functions?

• What are major causes of failure and breakdown of the axial/mixed flow pump?

• What is the solution if the pump shaft breaks or bends?
• Where can you collect new impellers?
• What is the best solution if there is water leakage from the pipe or pump?
• How do you prevent the transmission belt ripping? How do you deal with it when it rips?