



# Fundamentals of Hydraulic Engineering Systems

Fifth Edition

## Chapter 3a

Water Flow in Pipes

# Description of Pipe Flow Definitions and Visualization

## Definitions and Visualization

**Questions:** What is a streamline? What is a stream tube?

**Streamline:** imaginary lines drawn in the flow field which are everywhere tangent to velocity vectors

**Stream tube:** a grouping (bundle) of streamlines

### Visualization:

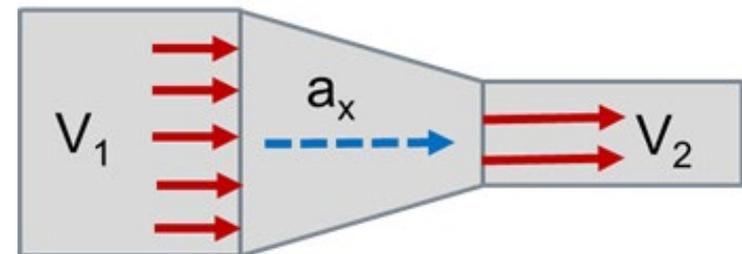
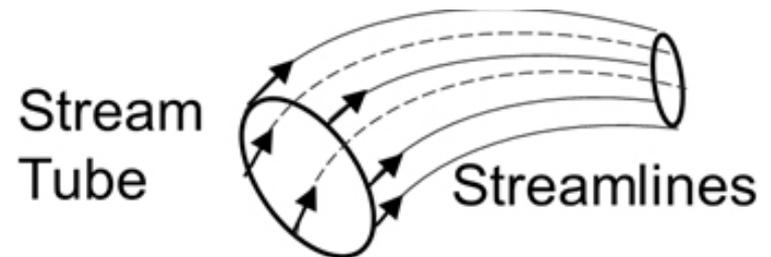
**Question:** Define steady flow?

**Question:** Given steady flow, is fluid acceleration possible?

**Local acceleration:**  $(dV/dt)$   
(equals zero in steady flow)

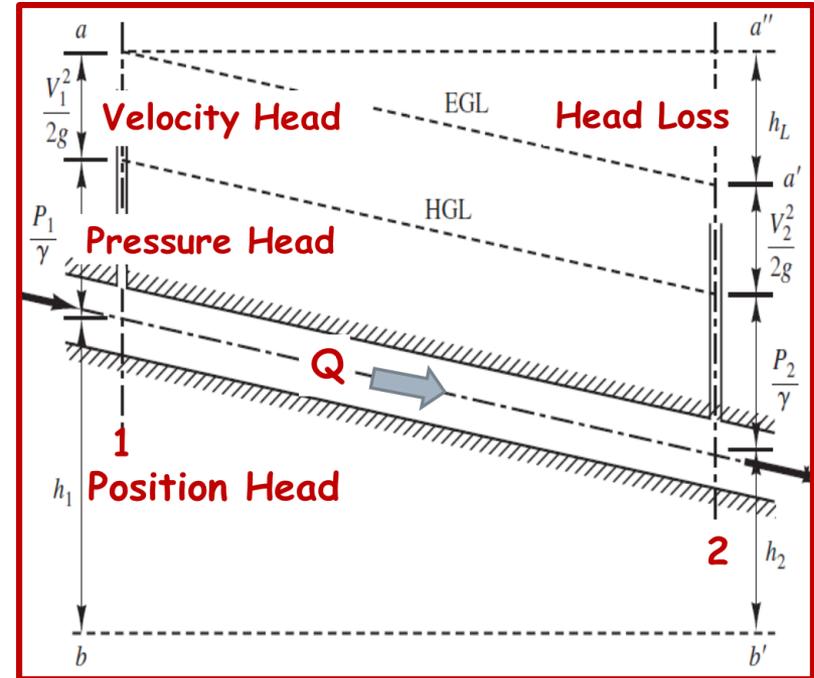
**Convective acceleration:**

$V(dV/ds) \rightarrow V$  change over distance

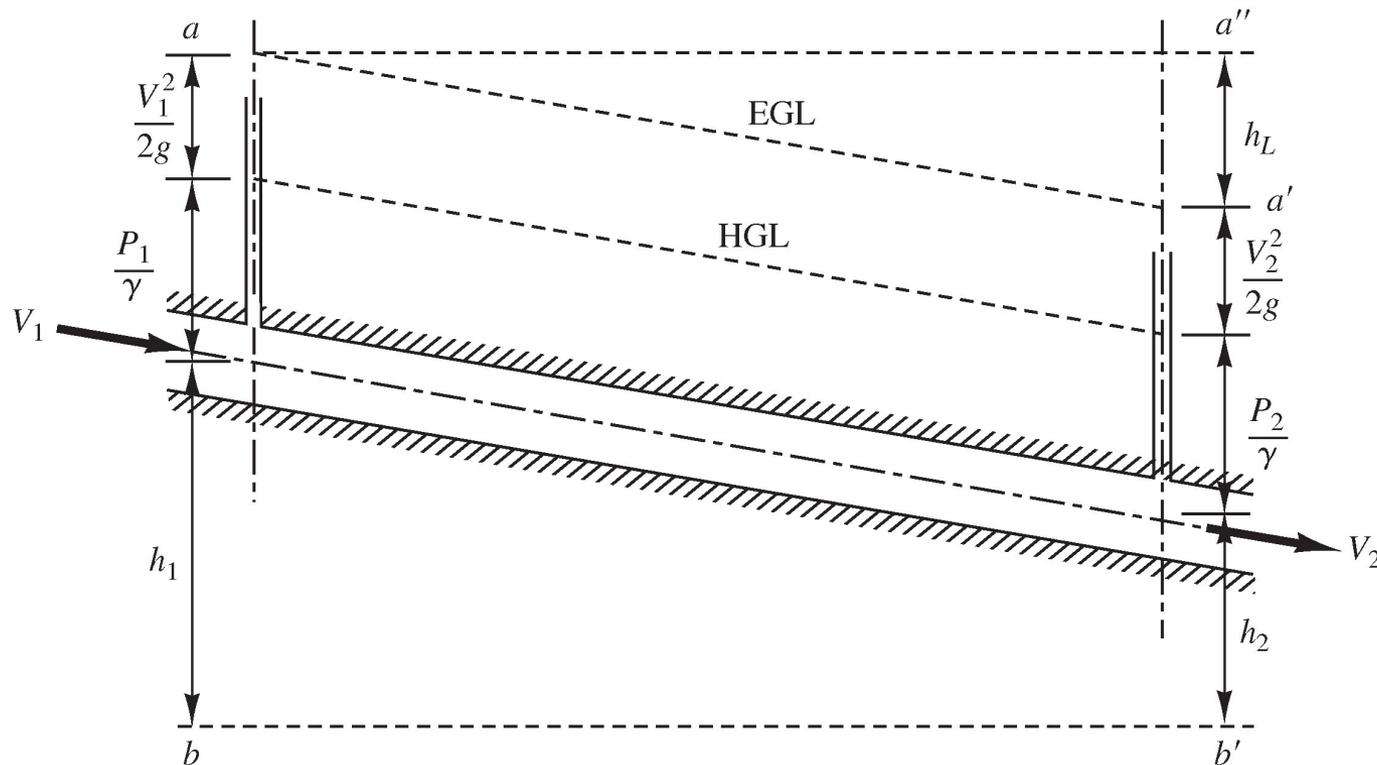


# The Energy Equation (1 of 2)

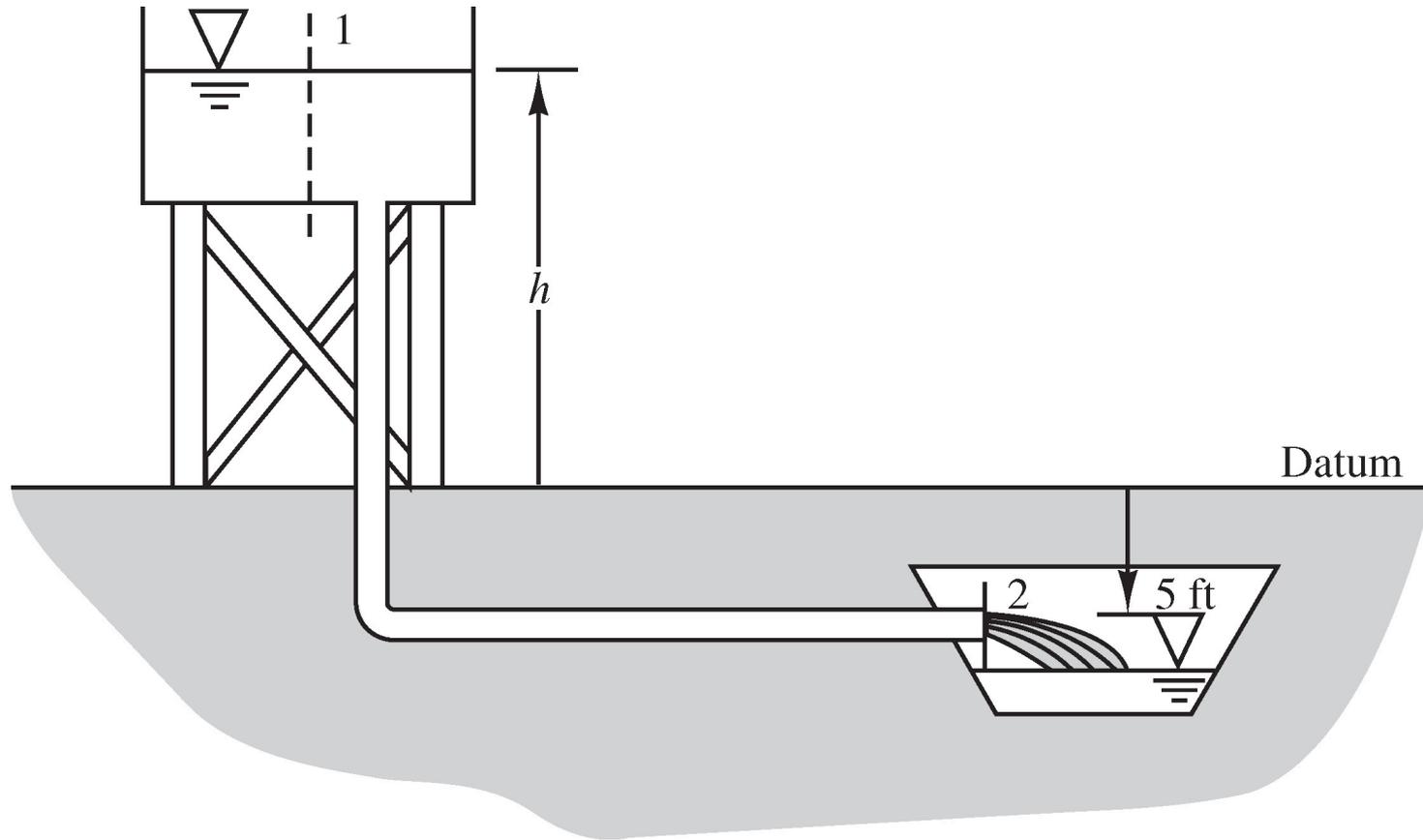
**Description and Visualization**  
From the pipe flow schematic:



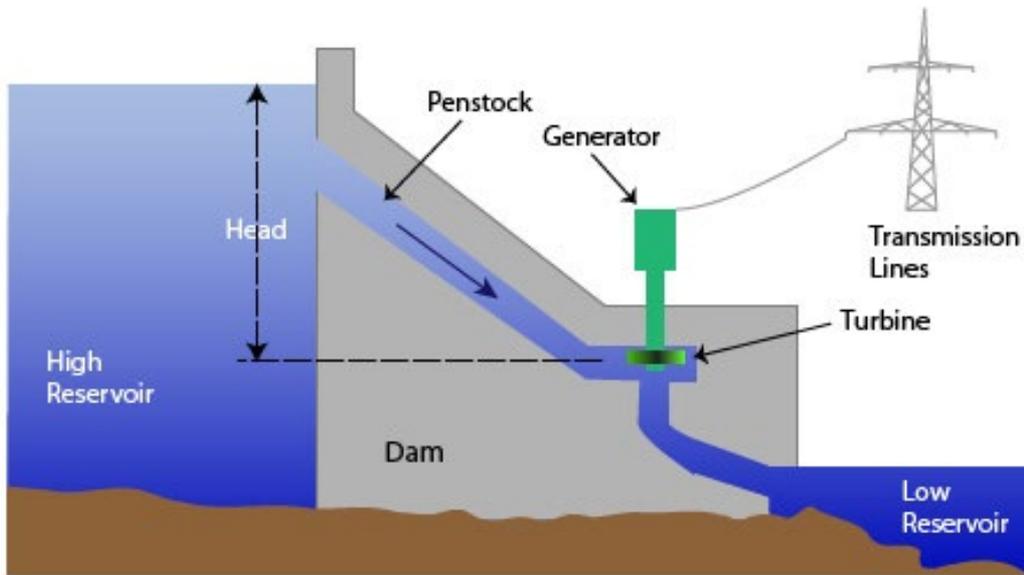
# Figure 3.5 Total Energy and Head Loss in Pipe Flow



# Figure 3.6 Flow from an Elevated Water Tank



# Hydroelectric Power Plants



These power plants transform hydraulic energy (position head of the water upstream) to electric (renewable) energy.

Hoover Dam is over 200m high.

# Copyright



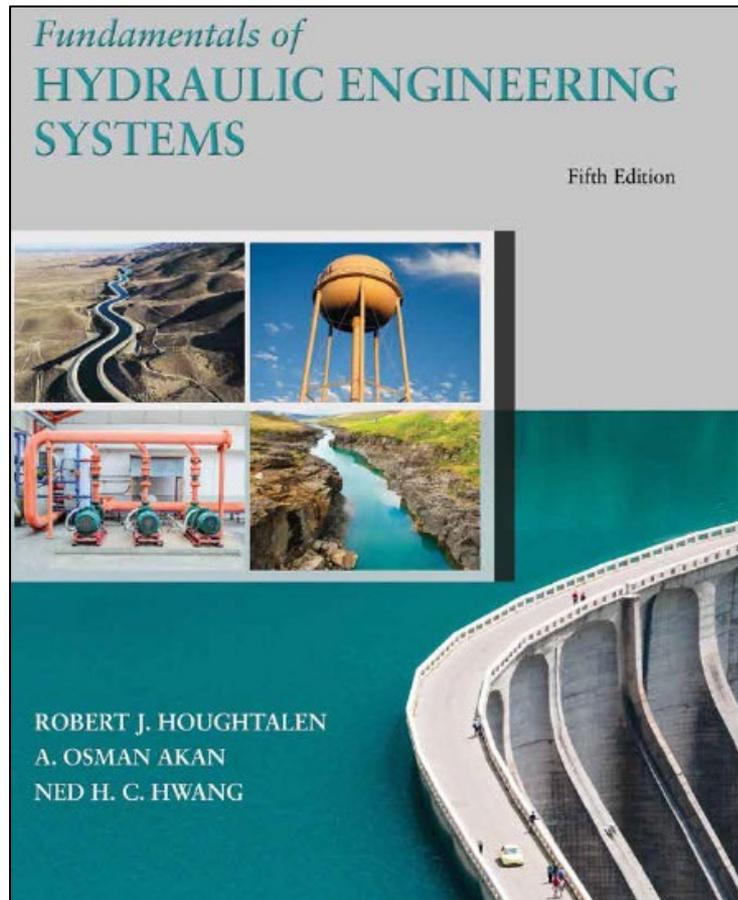
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## Chapter 3b

### Water Flow in Pipes