— University of Mosul —

College of Petroleum & Mining Engineering

Fluid Flow I

Lecture (2)

Dimension and Units

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LECTURE CONTENTS

Dimension and Units

Dimensions and Units

A standard unit for length might be a (meter or foot), for time might be (hour or second), and for mass a (slug or kilogram). Such standards are called units, and several systems of units are in common use as described in the following section. The qualitative description is conveniently given in terms of certain **primary** quantities, such as length (**L**), time (**T**), mass (**M**) and temperature ($\boldsymbol{\theta}$) . These primary quantities can then be used to provide a qualitative description of any other **secondary** quantity: for example; Area L^2, Velocity = LT^{-1}, Density = $ML^{-3}$and so on, where the symbol is used to indicate the dimensions of secondary quantity in terms of the primary quantities. Thus, to describe qualitatively a velocity, V, we would write $V = LT^{-1}$ and say that the dimensions of velocity equal length divided by time. The **primary quantities are also referred to as dimensions.**

For a wide variety of problems involving fluid mechanics, only the three basic dimensions (L, T and M) are required. Alternatively, (L, T, and F) could be used, where F is the basic dimensions of force. Since Newtons law states that force is equal to mass times acceleration, it follows that $F = MLT^{-2}$.

For the SI system there are four basic dimensions through which fluid properties are expressed.

Basic Dimensions are:

Mass (M)

Length (L)

Time (T)

Force (F)

There are two systems of dimensions

1. **M – L – T systems**
2. **F – L – T systems**

Quantity	**Dimension**	**Units**
Mass	M	Kilogram (kg)
Length	L	Meter (m)
Time	t	Second (s)
Temperature	T	Kelvin (K º)

Derived units:

Force = mass × acceleration = F = M× a = Kg × m/s^2 = MLT^{-2} (Newtons second law)

1. M – L – T systems

Quantity	Dimension	SI units	English Units
Area A	L^2	m^2	ft^2
Volume ∀	L^3	m^3 or L(liter)	ft^3
Velocity V	L/T	m/s	ft/sec
Acceleration a	L/T^2	m/s^2	ft/sec^2
Angular velocity Ω	T^{-1}	s^{-1}	sec^{-1}
Force F	ML/T^2	Kg. m/s^2 or N	slug.ft/sec^2 or Ib
Density ρ	M/L^3	Kg/m^3	$slug/ft^3$
Specific weight γ	M/L^2T^2	N/m^3	Ib/ft^3

Frequency f	T^{-1}	s^{-1}	sec^{-1}
Pressure p	M/LT^2	N/m^2 or Pa	Ib/ft^2
Stress τ	M/LT^2	N/m^2 or Pa	Ib/ft^2
Surface tension σ	M/T^2	N/m	Ib/ft
Work W	ML^2/T^2	N.m or J	ft.Ib
Energy E	ML^2/T^2	N.m or J	ft.Ib
Heat rate	ML^2/T^3	J/s	Btu/sec
Torque T	ML^2/T^2	N.m	ft.Ib
Power W	ML^2/T^3	J/s or W	ft.Ib/sec
Mass flux $\dot{m}$	M/T	Kg/s	slug/sec
Flow rate Q	L^3/T	m^3/s	ft^3/sec
Specific heat c	$L^2/T^2\theta$	J/kg.K	Btu/slug.R°
Dynamic viscosity μ	M/LT	$N.s/m^2$	$Ib.sec/ft^2$
Kinematic viscosity ν	L^2/T	m^2/s	ft^2/sec