AALSO Summary of Formulas needed for Levels I, II and III.

The information provided below is used in the math portion of the proficiency exams. Please take time to review and learn how to use these formulas all exam math questions will be based on this information.

Length

Length of a Circular Clarifier Weir or the Circumference of a Circle

Length, ft. = 3.14 (Diameter, ft)

Area

Rectangle or Square

Area, sq. ft. = (Length, ft)(Width, ft)

Triangle

Area, sq. ft. = 1/2 (Base, ft)(Height, ft)

Circle

Area, sq. ft. = $0.785(\text{Diameter, ft})^2$

Volume

Rectangle or Square

Volume, cu.ft. = (Length, ft)(Width, ft)(Height, ft)

Cylinder

Volume, cu.ft. = $0.785(\text{Diameter, ft})^2$ (Height, ft)

Sphere

Volume, cu.ft. = $0.524\ (\text{Diameter, ft})^3$

Pressure

Water pressure is measured in terms of pounds per square inch (psi) and feet of head (height of a water column in feet). A column of water 2.31 feet high creates a pressure of 1 psi. The water pressure at the bottom of a storage tank can be used to determine the water level in the tank. Centrifugal pumps are rated in feet of Total Dynamic Head (TDH) but system pressures are measured in psi. LS operators should be able to convert from one pressure unit to the other. If the pressure (psi) is known, The height of the water column can be determined by multiplying the psi by 2.31.

psi X 2.31 = Feet of Head

Chemical Feed / Dosage

$$\text{Pounds of Chemical} = \frac{\text{mg/L X 8.34 X Gallons}}{1{,}000{,}000}$$

$$\text{mg/L} = \frac{(\text{Pounds of Chemical})\ (1{,}000{,}000)}{8.34\ (\text{Flow, gals})}$$

$$\text{Pounds of Compound} = \frac{\text{lbs of pure}}{\%\ \text{Available}}$$

Tanks and Filters

$$\text{Retention Time / Turnover Time, hrs.} = \frac{\text{Tank Volume, gals.}}{\text{Flow, gph}}$$

$$\text{Hydraulic Loading Rate, gpm/sq.ft.} = \frac{\text{Flow, gpm}}{\text{Surface Area, sq. ft.}}$$

Efficiency of a Treatment Process

$$\text{Efficiency \%} = \frac{(\text{Influent Concentration})\ (\text{Effluent Concentration})(100)}{\text{Influent Concentration}}$$

BTU

$$\text{BTU's/hr} = \frac{\text{Gallons of water X 8.34 X Temp Increase}}{24,\ \text{hrs (\% Efficiency)}}$$

Conversions

$$gpm = (cfs)(7.48)(60)$$

$$cfs = \frac{gpm}{7.48X60}$$

$$^{O}F = (^{O}C \text{ X } 1.8) + 32^{O}$$

$$^{O}C = (^{O}F - 32^{O}) \text{ X } 0.556$$

Pumps

Definitions:
Total Dynamic Head (TDH) is the total height that a fluid is to be pumped, taking into account friction losses in the pipe. **TDH = Static Lift + Static Height + Friction Loss**
where:
Static Lift is the height the water will rise before arriving at the pump (also known as the '**suction lift**').
Static Height is the maximum height reached by the pipe after the pump (also known as the '**discharge head**').
Friction Loss is the head equivalent to the energy losses due to viscose drag of fluid flowing in the pipe (both on the suction and discharge sides of the pump). It is calculated via a formula or a chart, taking into account the pipe diameter and roughness and the fluid flow rate, density and viscosity.

In a system where the reservoir feeding the pump is higher than the pump, the difference in elevation (height) between the pump center line and the free water surface of the reservoir feeding the pump is termed **static suction head**

The **total static head** of a pump is the total height that a pump must lift the water from the level of one reservoir to the level of another.

- **Head** - a measure of the pressure or force exerted by the fluid.
- **Capacity** - the rate of liquid flow that can be carried.
- **Current** - the amount of electricity, measured in amps, which is flowing in a circuit.
- **Power input** - the electrical input to the motor expressed in kilowatts (kW). A measure of the rate at which work is done.
- **Voltage** - the potential or electrical magnetic force (EMF) in an electrical circuit.
- **Power factor** - the ratio of the true power to the volt-amperes in an alternation current (ac) circuit.
- **Motor efficiency** (**Em)**- a measure of how effectively the motor turns electrical energy into mechanical energy. It is the ratio of power input to power output.
- **Motor horsepower (MHp)** - the amount of electrical energy that must go into the motor to produce the required BHp.
- **Brake horsepower (BHp)** - the amount of energy that must go into the pump to produce the required WHp.
- **Hydraulic horsepower (WHp)** - the pump output or the liquid horsepower delivered by the pump.

• **Total efficiency** - the ratio of the energy delivered by the pump to the energy supplied to the input side of the motor. It is sometimes referred to as the 'wire to water efficiency'.

• **Pump efficiency (Ep)** - the ratio of the energy delivered by the pump to the energy supplied to the pump shaft.

Formulas:

MHp = BHp/Em or WHp/EmxEp

BHp = WHp/Ep

WHp = [Head (feet) * Capacity (GPM)] / 3960

Total efficiency = (WHp / EHp) * 100%

Ep = (WHp / BHp) * 100%

Kw-hours of electricity = MHp x 0.746 Kw/Hp x Hours

Cost to operate for a year = Duty cycle*Power input*Electrical cost ($/kW hour)*Hours in a year

Quantity, Velocity, Area

Quantity (Q)- Discharge Rate, measured in cubic feet per second (cfs)

Velocity (V)- Flow Rate, measured in feet per second (fps)

Area (A) - Pipe Size, measured in square feet (sq. ft.)

Find the unknown by using the following formulas:

$Q = A \times V$ $\qquad V = \frac{Q}{A}$ $\qquad A = \frac{Q}{V}$

Misc. Equivalents

1 cu ft water = 62.4 lbs

1 cu ft water = 7.48 gals

1 gal water = 8.34 lbs

1 gal water = 3.785 liters

17.1 ppm = 1 grain per gal

1 ppm = 8.34 lbs per million gal

1 ppm = 1 mg/l

1 psi = 2.31 ft of head

1 ft of head = 0.433 psi

1 Hp = 33,000 ft./ lbs. / min

1 Hp = 0.746 Kw

1 BTU = 1^{o}F increase in 1 lb of water in 24 hours