Tank Mania!

(1) Consider a 200 liter tank used to hold a dye solution with a concentration of 1 g/liter. The tank needs to be rinsed with fresh water flowing in a rate of 2 liters/min with the well-stirred solution flowing out at the same rate. Find the time that will elapse before the concentration of the dye in the tank reaches 1% of its original value.

(2) A tank originally contains 100 gal of fresh water. Then water containing 1 lb of salt per gallon is poured into the tank at a rate of 2 gal/min, and the mixture is allowed to leave at the same rate. After 10 minutes, the process is stopped, and fresh water is poured into the tank at a rate of 2 gal/min, with the mixture leaving at the same rate. Find the amount of salt in the tank at the end of an additional 10 minutes.

(3) A tank initially contains 100 gal of brine in which 50 lb of salt are dissolved. A brine containing 2 lb/gal of salt runs into the tank at the rate of 5 gal/min. The mixture is kept uniform by stirring and flows out of the tank at the rate of 4 gal/min. Find the amount of slat in the tank 25 minutes after the process starts.

(4) In an oil refinery, a storage tank contains 2000 gal of gasoline that initially has 100 lb of additive dissolved in it. In preparation for winter weather, gasoline containing 2 lb of additive per gallon is pumped into the tank at a rate of 40 gal/min. The well-mixed solution is pumped out at a rate of 45 gal/min. Find the amount of additive in the tank 20 minutes after the process starts.

(5) An executive conference room of a corporation contains 4500 cubic feet of air initial free of carbon monoxide. Starting at time $t = 0$, cigarette smoke containing 4% carbon monoxide is blown into the room at the rate of 0.3 ft^3/min. A ceiling fan keeps the air in the room well circulated and the air leaves the room at the same rate of 0.3 ft^3/min. Find the time when the concentration of carbon monoxide in the room reaches 0.01%.

(6) Consider a pond that initial contains 10 million gallons of fresh water. Water containing an undesirable chemical flows into the pond at the rate of 5 million gallons per year, and the mixture in the pond flows out at the same rate. Then concentration of the chemical in the incoming water varies periodically according to the expression $\gamma(t) = 2 + \sin 2t$ g/gal. Determine an expression for the amount of the chemical in the pond at a time t.