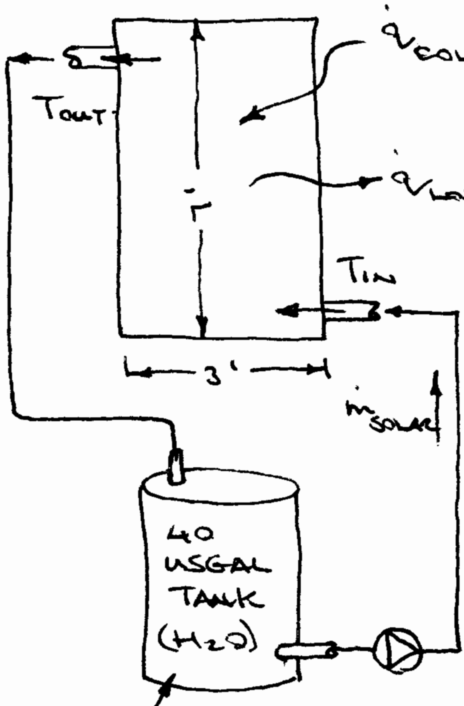
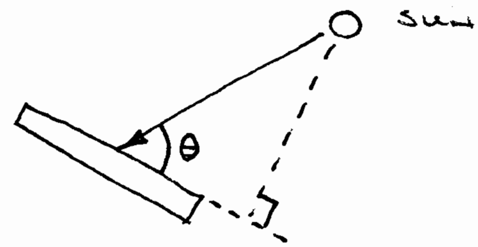
MODEL A SOLAR WATER HEATER THROUGH THE DAY



$m_{TANK} = 150\,kg$
(151 LITRES)

$\dot{m}_{SOLAR} = 0.25\ kg/s$

$\dot{q}_{SOLAR} = 1000\ W/m^2$ (ASSUME $\perp$)



$\dot{q}_{COLLECTOR} = \dot{q}_{SOLAR} \times \sin\theta$

IN OUR CASE ; $\theta = 90$

$\therefore\ \dot{q}_{COLLECTOR} = \dot{q}_{SOLAR}$.

(JUST TO KEEP IT SIMPLE).

ENERGY BALANCE (1ST LAW)

$$\dot{q}_{WATER} = \dot{q}_{COLL} - \dot{q}_{LOSSES}$$

SEE ABOVE

$$\dot{q}_{LOSSES} = \frac{T_{COLL} - T_\infty}{R}$$

$$T_{COLL} = \frac{T_{OUT} + T_{IN}}{2}$$

$$\dot{q}_{WATER} = \dot{m}_{SOLAR}\, C_p \,(T_{OUT} - T_{IN})$$

$(T_{OUT} - T_{IN})$ = TEMPERATURE RISE PER PASS

ALSO

$$\dot{q}_{WATER} = m_{TANK}\, C_p \frac{(T_{END} - T_{START})}{t_{WARMING}}$$

$(T_{END} - T_{START})$ = TEMPERATURE RISE DURING A WHOLE WARMING PROCESS.

$t_{WARMING}$ = LENGTH OF THAT WARMING PROCESS

THIS LOOKS LIKE A

TRANSIENT HEAT/COOLING PROCESS

IT IS CERTAINLY NOT STEADY STATE !

IS IT MORE LIKE ...

(a) CONSTANT POWER ($\dot{q}_s$ = CONSTANT)

OR

(b) CONSTANT TEMPERATURE (T_s = CONSTANT)

I'D SAY IT IS NOT T_s = CONSTANT.

IT'S MORE LIKE $\dot{q}_s$ = CONSTANT AS THE SUN IS SHINING AT CONSTANT POWER (MOL).

BEFORE LOOKING AT $\dot{q}_s$ = CONST. LET'S EXAMINE T_s = CONST TRANSIENT HEATING/COOLING.

(GO TO THE TEXT SECTION ON THIS AND THE EGG EXAMPLE).