Enrichment Problem-4

Assuming that the price per SWU is \$80 and the cost of conversion is \$4/kgU, what is the price of the U_3O_8 (\$lb/U_3O_8) beyond which it will cost less to enrich the already mined , purified, and converted (to UF_6) tails that contain 0.2% ^{35}U rather than mine new U?

Assume the product will be 3% enriched in either case and the new tails will be 0.1%(when the old tails are enriched). Tails stored as UF_6 cost nothing.

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From ore $$(PE)_{ore} = \frac{(PU + PC) \bullet F_0}{P_0} + PS \bullet S_0$$

From Tails $$(PE)_{tails} = PS \bullet S_t$$

Where S_o, S_t are the SWU factors for the ore and tails respectively

so, $$(PU + PC) \bullet \frac{F_0}{P_0} = PS(S_t - S_0)$$

or, $$PU = PS \bullet \frac{P_0}{F_0}(S_t - S_0) - PC$$

PE = price of enriched U

PU = price of Nat $U = \frac{(714 + 128)}{714} = 117.9\%$ of U_3O_8

PC = conv. cost = \$4/kg U
PS = SWU Price = \$80/kg U

$$S_0 = V(x_p) + V_0(x_w) \bullet \frac{W_0}{P_0} - V_0(x_f) \bullet \frac{F_0}{P_0}$$

$$S_t = V(x_p) + V_t(x_w) \bullet \frac{W_t}{P_t} - V_t(x_f) \bullet \frac{F_t}{P_t}$$

$$V(x_i) = (2x_i - 1) \bullet \ln\left[\frac{x_i}{(1 - x_i)}\right]$$

	ore	tails
x_p	0.03	0.03
x_w	0.002	0.001
x_f	0.00711	0.002

$V(x_p)$ =3.3718
$V_o(x_w)$ =6.1878
$V_t(x_w)$ =6.8929
$V_o(x_f)$ =4.869
$V_t(x_f)$ =6.1878
or,

$$S_t - S_0 = V_t(x_w) \bullet \frac{W_t}{P_t} - V_t(x_f) \bullet \frac{F_t}{P_t} - V_o(x_w) \bullet \frac{W_0}{P_0}$$
$$+V_0(x_f) \bullet \frac{F_0}{P_0}$$

$$\frac{F_0}{P_0} = \frac{(x_p - x_w)}{(x_f - x_w)} = \frac{(3 - 0.2)}{(0.711 - 0.2)} = 5.4795$$

$$\frac{F_t}{P_t} = \frac{(x_p - x_w)}{(x_f - x_w)} = \frac{(3 - 0.1)}{(0.2 - 0.1)} = 29$$

$$\frac{W_0}{P_0} = \frac{F_0}{P_0} - 1 = 5.4795 - 1 = 4.4795$$

$$\frac{W_t}{P_t} = \frac{F_t}{P_t} - 1 = 29 - 1 = 28$$

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$$S_t - S_0 = 6.8929 \bullet 28 - 6.1878 \bullet 29 - 6.1878 \bullet 4.4795$$
$$+4.869 \bullet 5.4795$$

$$= 193.0012 - 179.4462 - 27.7183 + 26.6797$$

$$= 12.5164$$

Remembering, $$PU = PS \bullet \frac{P_0}{F_0}(S_t - S_0) - PC$$

$$PU = 80 \bullet \left(\frac{1}{5.4795}\right) \bullet 12.5164 - 4$$

$$PU = 182.7378 - 4$$
$$PU = 178.74$$

$$\text{Price of } U_3O_8 = 178.74*0.848 = 151.57 \ \frac{\$}{kg}$$

$$\boxed{68.9 \ \$/lb \ U_3O_8}$$