Fertile: A fuel material which in itself is not fissionable but following neutron assertion can produce fissionable products e.g ^{238}U produces ^{239}Pu.

Fissile: Fuel material capable of ~~undergoing~~ sustaining a fission process e.g ^{235}U.

Fissionable: A material capable of undergoing ~~and sustaining~~ a fission process even with slightest probability of doing so. e.g ^{235}U.

(f) Disadvantages of pure uranium as fuel include:

(c) has thermal conductivity.

(b) Swelling tendency of uranium under thermal and irradiation stress - anisotropically

(g) Smear density is defined as the ratio of fuel volume to the total internal volume of the fuel element it self. It subsequently depends on the shape - cylinder, sphere, e.t.c of the fuel.

It is important as it helps fuel design engineers in terms of understands the nature and degree of swelling the fuel will undergo in it's life time, which consequently determines it's performance and tendency/nature of reacting to sustained temperature and irradiation stress.

(9) (a) Since only ^{235}U is fissile, we need to enrich uranium to increase the amount/density of ^{235}U per sample to increase/improve the fission process and thus fuel efficiency.

(b) Uranium ~~He~~ Hexafluoride.

(c) UF_6 gas is placed in a fast spinning centrifuge. The heavy molecules → ^{238}U are pushed outwards under centrifugal forces, leaving lighter molecules — ^{235}U inwards. ~~This is the~~ on.

(10)

	Strength	Weakness
(a) Finite difference :	(a) Simple and easy to code	Difficult to model complex boundary conditions.
(b) Finite volume	(b) Accomodates heterogenous properties	complicated, at least in comparison to finite difference
(c) Finite element	(c) Can model all geometry	Complicated and expensive.

It is the ratio of the heat flux that causes all water to turn to steam to the actual heat flux.

It determines our safety limit.

(a) - Fuel kernel
- Buffer layer
- Inner pyrolitic carbon layer
- Silicon carbide layer
- outer pyrolitic carbon layer

(b) Molten Salt reactors.

(a) $Z = 3.5\,M \qquad \gamma = 1.3$

$Z_0 = \frac{3.5}{2} \qquad LHR^0 = 350\ W/cm$

$LHR\left(\frac{1.4}{3.5}\right)_m = LHR^0 \cos\left(\frac{\pi}{2\gamma} * \left(\frac{Z}{Z_0} - 1\right)\right]$

$\therefore\ LHR\left(\frac{1.4}{3.5}\right)_m = 350 \times \cos\left(\frac{3.14}{2(1.3)} * \left(\frac{1.4}{\frac{3.5}{2}} - 1\right)\right)$

$\Rightarrow 349.99\ W/cm.$ //

~~$= 350 \times$~~

~~$= 349.97\ W/cm.$~~

(b) $\Delta T_{cool} = \frac{1}{\gamma} * \frac{Z_0 \times LHR^0}{m \times C_{P,0}} * \left(\sin\gamma + \sin\left(\gamma\left(\frac{Z}{Z_0} - 1\right)\right)\right)$

$= \frac{1}{1.3} \times \frac{1.75 \times 350}{4200 \times 0.22} \times \left(\sin(1.3) + \sin\left(1.3\left(\frac{1.4}{\frac{3.5}{2}} - 1\right)\right)\right)$

$\Rightarrow 0.0092545^0 K.$

//

(a) $Q = E_f \times N_f \times \bar{\sigma}_f \times \phi$

$= (200 \times 10^6 eV) \times (1.602 \times 10^{-19}) \times 570 \times 10^{-24} \times 5 \times 10^{12} \times N_f$

where N_f = Mass of Uranium at 19.5% enrichment = $235 \times 0.195 + 238 \times 0.805 = 237.14$ amu.

Mass of Uranium monomide = $(0.96 \times 237.4) + (0.04 \times 14) = 228.46$

~~227.904~~

$\therefore N_f = \dfrac{12.3 \times 6.022 \times 10^{23} \times 0.96 \times 0.195}{228.46} \Rightarrow 6.069 \times 10^{21}$

$\Rightarrow$ 554.216 W/cc //.

(b)

$\dfrac{dy}{dt} = t \times 10^{-2t}$ $t_0 = 0$, $y_0 = 4$. $\Delta t = 0.5$

Backward: $y_{n+1} = y_n + \Delta t\, y'_{n+1}$

~~$t_0 = 0$~~, ~~$y_1 = y_0$~~ $y_1 = y_0 + \Delta t\ (y_{n+1})$

~~$y_{n+1} =$~~ $y_1 = 4 + 0.5\,(0.5 \times 10^{-2(0.5)})$

$y_1 = 4 + 0.025$

$y_1 = 4.025$.

t

$y_2 = 4.025 + 0.5\,(1 \times 10^{-2(1)})$

$= 4.075$.

$y_3 = 4.075 + 0.5\,(1.5 \times 10^{-2(1.5)})$

$= 4.07575$ //

(2) Without coating i.e fuel has no coating.

$2\pi R_f = 3.768$

$LHR = 250$

(a) (1) Temp inside cladding = Temp outside cladding + $\frac{LHR \times \text{cladding thickness}}{2\pi R_f \times K_{cladding}}$

$$= 600 + \frac{250 \times 0.05cm}{2\pi(0.6) \times 0.15}$$

$$= 600 + 22.12$$

$$= 622.12K.$$

(1) Temp outside fuel (i.e fuel surface) = $622.12 + \frac{250 \times \text{gap thickness}}{3.768 \times K_{gap}}$

$$= 622.12 + \frac{250 \times 0.005}{3.768 \times 0.004}$$

$$= 705.06^{\circ}K.$$

(3) Centre line $\Rightarrow 705.06 + \frac{250}{4\pi K_f}$

$\Rightarrow 705.06 + \frac{250}{4(3.14)(0.05)}$

$\Rightarrow 1103.15^{\circ}K.$ //

(b) With coating.

(1) Temp inside cladding is same = 622.12K.

(2) Temp outside fuel coating = $622.12 + \left[\frac{250 \times (0.005 - 0.01)}{3.768 \times 0.004}\right]$

$\Rightarrow 539.18^{\circ}K$

(3) Temp at surface of fuel proper = $539.18^{\circ}K + \frac{250 \times \text{thickness of coating}}{3.76 \times k \text{ of coating}}$

$= 539.18^{\circ}K + \frac{250 \times 0.01\,cm}{3.76 \times 0.015}$

$\Rightarrow 583.41^{\circ}K$.

(4) Temp at center line = $583.41 + \frac{250}{4\pi C k_c}$

$\Rightarrow 981.50^{\circ}K$ //.