HYPOTHETICAL FUSION BURN

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This is a thought experiment, done to establish whether a fusion reactor once ignited has the potential to runaway and cause an exponential temperature rise in the reactor core.

In the various fusion reactions some of the energy is captured and retained in the reaction chamber and some of the energy escapes with the neutron, and it is the balance between the two that determine how the temperature rises in the core of the reactor.

For the purpose of this thought experiment we shall assume that our hypothetical Fusor is designed so that it has a zero loss due to heat convection, bremsstrahlung, x-rays etc.

The only heat loss from our hypothetical Fusor are the neutrons and the kinetic energy that they carry away. It is assumed that the Fusion product plus any alpha particles can be retained in the reaction chamber and contribute to heating the remaining plasma.

For accounting purposes I shall have exactly 300 Deuterium atoms in the reaction chamber, and they shall react with each other as follows, to create the ideal burn.

REACTIONS FROM 300 *DEUTERIUM ATOMS*

Reaction	*Result*	*Energy Captured* $Mev.$	*Energy Lost* $Mev.$
$50D + 50D \longrightarrow$	$50T$	50.50	-
	$50p$	151.00	-
$50D + 50D \longrightarrow$	$50He3$	41.00	-
	$50n$	-	122.50
$50D + 50T \longrightarrow$	$50He4$	175.00	
	$50n$	-	705.00
$50D + 50He3 \longrightarrow$	$50He4$	180.00	-
	$50p$	735.00	-
$25T + 25T \longrightarrow$	$25He4$	-	-
	$50n$	-	282.50
		1332.50	1110.00
$100B11 + 100p \rightarrow$	$300He4$	870.00	-
	Total	2202.00	1110.00

As we can see, the ideal burn with only Deuterium results in a $1 : 1.2$ *ratio between energy lost to neutron radiation and energy that remains to heat the plasma. In a perfect Fusor the D+D reaction might burn, but in reality losses due to convection, X-Rays etc. will kill any chance of that.*

However, to significantly improve the odds, add 100 *atoms of* $B11$ *to every* 300 *atoms of Deuterium. The Deuterium reactions have left a surplus of* 100 *protons that can react with Boron*11 *and release another* 870.00 Mev *as heat in the reaction chamber. This results in a ratio of* $1 : 1.98$. *Providing your Fusor is capable of retaining* 50% *of the captured energy generated in the chamber, you may run the risk of a runaway reaction.*

References:

http://www.brian-mcdermott.com/fusion_process.htm