THE FIEDLER CYCLE

The basic concept of the Fiedler Cycle is that proper combustion can be realized only if a stoichiometric fuel/air ratio is formed before temperatures are high enough to induce pre-combustion reactions. In ordinary engines which burn vapor and air or atomized fuel droplets and air, too little attention is given to the rate at which fuel absorbs heat in relation to the rate at which it mixes with the air. Thus, the fuel undergoes pre-combustion reactions which make controlled, complete combustion impossible.

The J-F 24 engines operate using the following concept:

Air pressure built up in the crankcase partially scavenges exhaust gases while the piston is still near the bottom of its stroke. About 20% of the exhaust gas remains to reduce pumping losses, retain heat and avoid forcing the minute quantities of fuel oil in the scavenging air into the exhaust.

Just after the ports are covered by the rising piston, an impulse is generated in the injection pump. The effective stroke of this pump's piston is of minimal importance. The resistance of the bypass ports in the pump is the important factor. The pulse produced by the pump provides a pressure wave which lifts the injector nozzle's constant pressure valve. Droplets of precisely controlled, large size are injected in a brief, low pressure spray whose pattern is tailored to the production of a stoichiometric air/fuel ratio between the droplets.

Fuel and air form a stoichiometric mixture before the fuel has become hot enough to undergo pre-combustion reactions because:

1. The large droplet size slows heat transfer to the droplets. The

surface-to-volume ratio of a large droplet is smaller.

2. The low injection pressure produces droplets whose low velocity allows natural turbulence within the chamber to quickly and efficiently distribute the droplets throughout the chamber.

Of course, such a process has a number of desirable aspects from the point of view of emission control. They are:

1. An equilibrium flame temperature substantially below the temperature range in which nitrogen oxide compounds are formed.

2. Improved, smoke-free combustion at near stoichiometric ratios because of:

A. Maximum chemical unity between the very potent hydrogen combustion and combustion of carbon. The bonds which hold the carbon in the molecule thus help accelerate it to combustion conditions (e.g. the ignition temperature of a hydrocarbon is 450-480° F. while pure carbon must be 1600°F. to burn). Thus, the reaction follows a path which minimizes the formation of difficult-to-burn compounds. Also, leaving the fuel intact as long as possible ensures that all parts of the molecule will burn in close proximity to each other, allowing the lighter elements to support and stabilize combustion of the heavier elements. Finally, the low equilibrium temperature that applies throughout combustion ensures easier completion of reactions which cannot occur during the early part of the combustion cycle in ordinary engines ($CO-CO_2$ cannot occur above 2000° F. approximately).

B. Maximum availability of oxygen due to pre-mixing and high pressures.

C. Minimum quenching due to precisely controlled and injected spray, use of an insulated coating on cylinder walls to reduce absorption of heat, and those factors relating to the reaction path discussed above.

3. The brief injection pulse together with the very early injection timing allows plenty of time for pre-mixing of fuel and air and formation of a combustible ratio while chamber temperatures are still very low.

Fiedler's research indicates that two very desirable side-effects occur when oxidation reactions precede breakdown of the hydrocarbon. These are:

1. A very low equilibrium flame temperature (1800-2000°F.).
2. A tendency to resist reaction under conditions of rapid pressure rise.

Therefore, with the 34:1 compression ratio used in the engine, combustion is controlled by chemical forces as follows:

1. During compression, chamber temperatures are very low until near Top Center, an effect especially pronounced with high ratios. As the piston approaches TDC, pressure rise comes very rapidly. Energy is forced into the reaction faster than release can occur.
2. As pressure rise slows as the piston reaches TDC, chamber temperature rise due to compression has brought the temperature beyond equilibrium temperature, thereby further delaying combustion.
3. As pressure and temperature fall during the downstroke, temperature falls below equilibrium level and reaction begins. From beginning to end the reaction occurs right near the equilibrium temperature of just under 2000°F. A precise balance between rate of conversion of chemical energy to heat and heat to mechanical energy then exists throughout the combustion

portion of the cycle, maintaining constant temperature combustion until all the fuel has been consumed. Final exhaust temperature is 400° F.