Frac Jobs

The most common stimulation technique used today, well over ¾ of the wells are completed with frac jobs.

History
First one in 1947, oil based, Stanolind Oil, Hugoton gas field in Kansas. In the mid 1950 water based gels were introduced, then the cross linked gels came in during the early 60s. This is when frac jobs started to become more common.

Basic idea
A frac job is simply causing the failure in the rock using hydraulic pressure and then filling that crack or fracture with a proppant to prevent it from closing once the pressure is relieved.
The basic job is to first pump a pad of gelled fluid to cause the fracture to open, this is followed by stages with increasing sand concentrations in the gelled fluid. There is a flush to cleans out the wellbore and gets all of the sand into the fracture.
The direction of the fracture is dependant on the primary stress in the rock at the time of the job. The fracture is parallel to the max stress. The fracture is usual vertical but in shallow wells, less than 2000’, it can be horizontal. The height of the fracture is governed by the rock beds above and below the pay zone. Changes in rock properties will cause the fracture from growing. The length of the fracture is limited by the size of the job, the rate and the leak off of the frac fluid. The tubulars and the perforation design play a major rule in the pressures need to do the job.

Pretreatment Work
Frac jobs require planning, they are expensive and complex to run. The more you know the better.

Data gathering.
Need to get as much data as possible on the reservoir both rock and fluids. Also the well itself, tubing, casing, perforations, well head.
Reservoir Information
- Pore pressure
- Fluids in the formation (oil, water, gas)
- Saturations of the fluids
- Matrix permeability
- Skin damage
- Flow boundaries (how big is the reservoir)
- Future production (Will job pay for itself)

Rock Information
- Porosity
- Stresses in the rock
- Stress direction in the rock
- Young’s Modulus
- Leak off coefficient
- Frac pressure
- Reservoir temperature

Once the data has been collected, as best it can, the job can be designed. Knowing the formation thickness, along with a desired production increase the size of the job can calculated. Normally the longer the frac length the greater increase in production.

Now that a target for the frac length is known the fluids can be designed, using the rock properties and leak off coefficient. Get as much fluid and sand in the formation without screening out. Also the compatibility of the treatment fluids with the formation fluids must be taken into account. The sand program can now be set up. The type of proppant is based on the closing stress of the rock, the size of the sand by the desired perm in the frac, concentration based on the width and length of the frac.

The rate and pressures are next. The rate is based on the design of the length. The pressures are a function of rock properties, pore pressure and well configuration. The friction pressure in the job comes from the pipe that the job is pumped down (casing or tubing) the perforations (number and size). Also the properties of the frac fluid are part of these calculations. The clean up of the job depends on the frac fluid also, the breaker used.
Where do we get this info.  
Rock properties can come from well logs, the sonic log is very helpful. Also cores if you can get them can tell you the stress direction, mineralogy of the rock, perm and porosity. Maybe the fluid saturations and properties. In most cases the saturations will come for logs, as will the porosity. The shape of the open hole can also be an indication of the stress direction, if the right caliper is run.

Pressure transient test will give the reservoir pressure, and perm along with the skin.

Minifracs are also used to get the data needed. This is a good practice in a new area where there will be a large number of future job. Also if there has been trouble with previous jobs in the area. You can get the rock properties and also a good handle on the leak off coefficient of the reservoir. Another source of data is the acid job that is usually run before the frac job, the ISDP can be used to calculate the frac pressure of the reservoir.

Of course any previous run jobs in the area for your reservoir is a good source of information. Experience is always a positive factor.