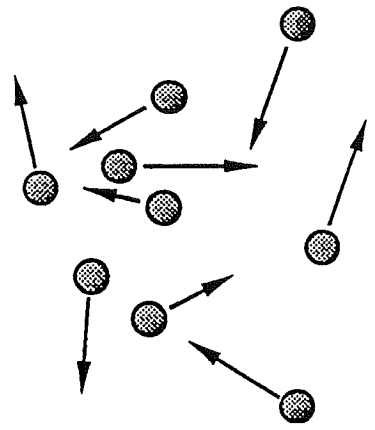
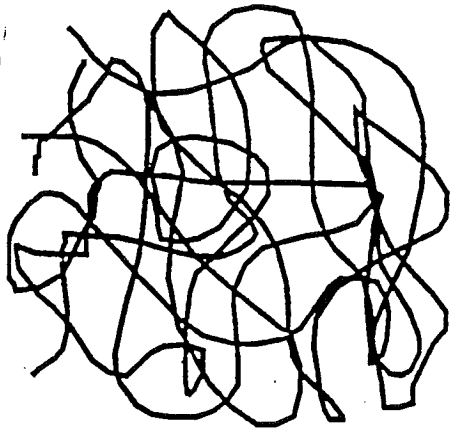
WHAT MAKES A FLUID A BINGHAM OR POWER-LAW FLUID?

BASIC UNIT OF NEWTONIAN FLUID IS MOLECULE, USUALLY < 100 ANGSTROMS LONG (10^{-6} cm)

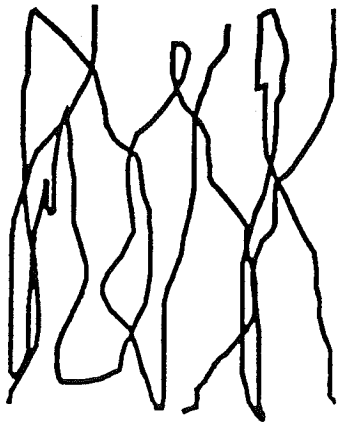
BASIC ORIGIN OF VISCOSITY IN NEWTONIAN FLUIDS IS MOLECULAR COLLISIONS, i.e. EXCHANGE OF MOMENTUM BETWEEN MOLECULES





BASIC UNIT OF POWER-LAW FLUIDS IS USUALLY EXTREMELY LONG POLYMER MOLECULES - 10^6 ANGSTROMS OR LONGER

THESE MOLECULES GET TANGLED - INCREASES APPARENT VISCOSITY



THEY USUALLY STRETCH OUT AND UNTANGLE AND HIGHER SHEAR RATES → LOWER EFFECTIVE VISCOSITY (SHEAR-THINNING BEHAVIOR)

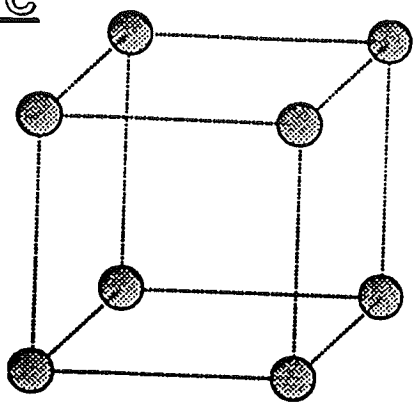
IF THEY CAN'T UNTANGLE AT HIGH SHEAR RATES → HIGHER EFFECTIVE VISCOSITY (SHEAR-THICKENING BEHAVIOR)

BASIC UNIT OF BINGHAM PLASTIC IS USUALLY A CRYSTAL-LIKE ARRANGEMENT OF SMALL PARTICLES

"CRYSTAL" STRUCTURE RESISTS DEFORMATION AT LOW τ - BEHAVES LIKE SOLID

HIGHER τ TEARS UP STRUCTURE - FLUID BEGINS TO FLOW

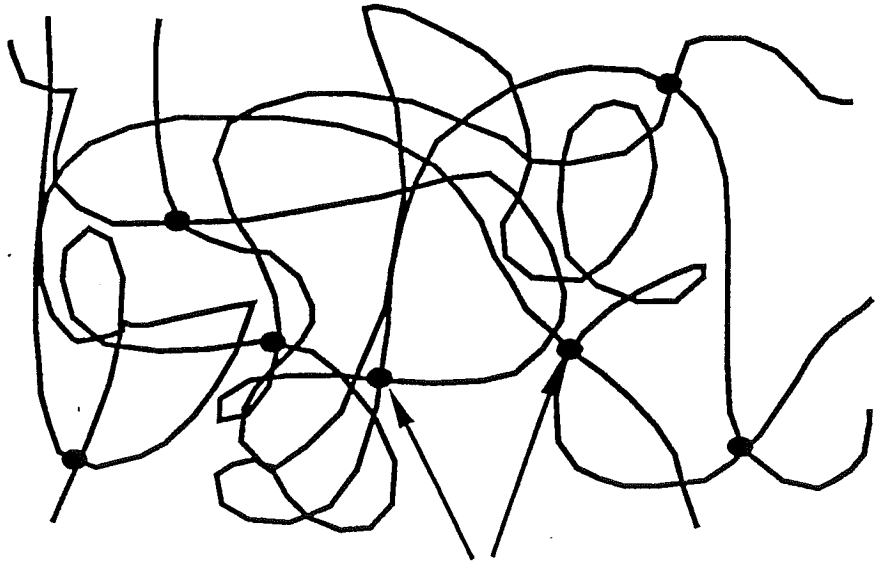
Alternative structure: polymer gel (below)



BOTH BINGHAM AND POWER-LAW FLUIDS HAVE MOLECULES OR STRUCTURES THAT CAN BE BIGGER THAN PORE THROATS IN ROCK

ON PORE SCALE THESE FLUIDS ARE NOT HOMOGENEOUS

MODELS ARE NOT VERY ACCURATE IN THESE CASES - ESPECIALLY BINGHAM PLASTIC



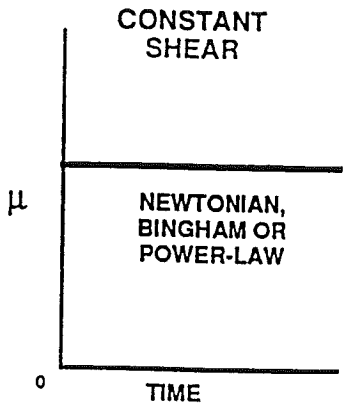
WEAK CHEMICAL OR ELECTROSTATIC BONDS

STRUCTURE OF A POLYMER GEL

II. D. 6.

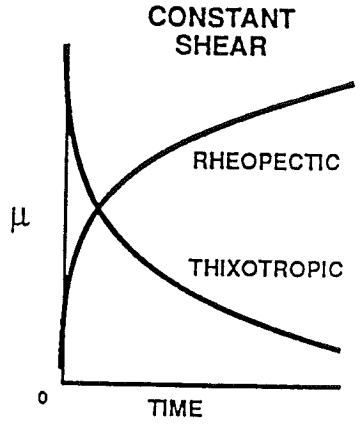
MORE-COMPLEX FLUIDS

FOR NEWTONIAN, BINGHAM AND POWER-LAW FLUIDS, RELATION BETWEEN τ AND $\frac{dV}{dx}$ DEPENDS ON SHEAR RATE, BUT NOT ON TIME



TIME DEPENDENT FLUIDS:

- THIXOTROPIC - VISCOSITY DECREASES WITH *TIME* AT CONSTANT τ
- RHEOPECTIC - VISCOSITY INCREASES WITH *TIME* AT CONSTANT τ



VISCOELASTIC - VISCOSITY DEPENDS ON RECENT SHEAR HISTORY