is thought that
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S_8 ring structure
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Waals, dipole and

(a) Relatively small molecules
E.g. CCl_4, O_2, Cl_2, C_2H_5Br, ether, decane, acetone, ethyl acetate, etc.

(b) Very long chain molecules
E.g., Linear polymeric resins, such as polystyrene, polyisobutylene, polyvinyl esters, etc.

Very long chain hydrocarbons, such as sone lubricating oils

Selenium and μ-sulfur

Raw rubber

II. Cohesive forces are directed forces in part

(a) Hydrogen bond structure
E.g., H_2O, NH_3, alcohols, sugars, alkaloids, nonhardening resins such as cresol-formaldehyde: in general, any liquid whose molecules have OH or NH groups.

(b) Covalent bond structure
E.g., SiO_2, GeO_2, B_2O_3, P_2O_5, BeF_2 and all silicate, borate and phosphate liquids which are not too basic.

Hardening resins such as phenol-formaldehyde, glycerol-phthalic anhydride, etc.

III. Metallic liquids—Molten metals

IV. Ionic liquids—Molten salts.

The applications of the theory thus far have been limited to Group I(a), the so-called normal liquids (and also to liquid metals and μ-sulfur). Glass-forming liquids are limited to Groups I(b), II(a) and II(b), and in fact most liquids in these groups do form glasses. Groups III and IV are really subdivisions of Group I, but are classified separately for obvious reasons.

In applying the theory to other than normal liquids three points are of importance:

(1) What is the structure of the liquid?
(2) What is the unit of flow?
(3) What is the energy of vaporization of this unit of flow?

In normal liquids the structure of the liquid is fairly certainly known and the unit of flow is without question the molecule, and furthermore the unit of flow and the unit of vaporization are undoubtedly the same. In other than normal liquids the unit of flow, the unit of vaporization,

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and the stoichiometric molecule need not necessarily be the same.

For any liquid we have the generalization that the energy of making a molecule-sized hole in the liquid is equal to the energy of vaporization, and that

$$\Delta E_{vap} = \tfrac{1}{2}\sum \text{energy of all attractive and repulsive forces}$$

$$= \tfrac{1}{2}[\sum_i E_{1i} \text{ (van der Waals)} + \sum_i E_{1i} \text{ (dipole)}$$
$$+ \sum_i E_i \text{ (structural bonds)}], \quad (11)$$

neglecting repulsive forces. When an elementary flow process takes place in a liquid possessing a directed bond structure, not only must a hole be provided, but in addition structural bonds must be broken. It seems probable that the energy of activation for flow in a structural liquid will then be $\tfrac{1}{3}$ or $\tfrac{1}{4}$ of the energy of vaporization due to undirected forces *plus all* of the energy of vaporization due to structural bonds:

$$\Delta E_{vis} = 1/n \Delta E_{vap} \text{(undirected forces)}$$
$$+ \Delta E_{vap} \text{(structural bonds)}. \quad (12)$$

In normal liquids the last term is zero. In liquids containing hydrogen bonds (Group II(a)) the two components of the energy of vaporization will be comparable in magnitude since the energy of a hydrogen bond is about 6000 cal. But in Group II(b) liquids the energy of breaking the structural bonds will be practically the whole energy of activation, and van der Waals and dipole attractions can be neglected in comparison, e.g., liquid SiO_2.

All this applies, of course, to the actual unit of flow, whatever it may be. The unit (or units) of flow can usually be determined if the structure of the liquid and the strength of all the bonds concerned are known. Flow will take place by all possible units of flow, but chiefly by the most economical one, i.e., the one with the smallest energy of activation. For example in liquid SiO_2 the units of flow SiO, SiO_2, SiO_3, and SiO_4 would all require the breaking of $4\ Si-O$ bonds, while any unit of flow containing two silicon atoms would require the breaking of $6\ Si-O$ bonds. Since the energy of an $Si-O$ bond is 100,000 cal., the unit of flow will be SiO_2, or an appropriate mixture of all four of the groups