

Visbreaking is a relatively mild thermal cracking operation mainly used to reduce the viscosities and pour points of vacuum tower bottoms to meet No. 6 fuel oil specifications or to reduce the amount of cutting stock required to dilute the resid to meet these specifications. Refinery production of heavy fuel oils can be reduced from 20–35 % and cutter stock requirements from 20–30% by visbreaking. The gas oil fraction produced by visbreaking is also used to increase cat cracker feed stocks and increase gasoline yields. Long paraffinic side chains attached to aromatic rings are the primary cause of high pour points and viscosities for paraffinic base residua. Visbreaking is carried out at conditions to optimize the breaking off of these long side-chains and their subsequent cracking to shorter molecules with lower viscosities and pour points. The amount of cracking is limited, however, because if the operation is too severe the resulting product becomes unstable and forms polymerization products during storage which cause filter plugging and sludge formation. The objective is to reduce the viscosity as much as possible without significantly affecting the fuel stability. For most feedstocks, this reduces the severity to the production of less than 10% gasoline and lighter materials. The degree of viscosity and pour point reduction is a function of the composition of the residua feed to the visbreaker. Waxy feed stocks achieve pour point reductions from 15–35 F (–3 to 2 C) and final viscosities from 25–75% of the feed. High asphaltene content in the feed reduces the conversion ratio at which a stable fuel can be made [15] which results in smaller changes in the properties. The properties of the cutter stocks used to blend with the visbreaker tars also have an effect on the severity of the visbreaker operation. Aromatic cutter stocks, such as catalytic gas oils, have a favorable effect on fuel stability and permit higher visbreaker conversion levels before reaching fuel stability limitations [17]. The molecular structures of the compounds in petroleum which have boiling points above 1000 F (538 C) are highly complex and historically have been classified arbitrarily as oils, resins, and asphaltenes according to solubility in light paraffinic hydrocarbons. The oil fraction is soluble in propane while the resin fraction is soluble (and the asphaltene fraction insoluble) in either pentane, hexane, n-heptane, or octane, depending upon the investigator. Usually either pentane or n-heptane is used. The solvent selected does have an effect on the amounts and properties of the fractions obtained but normally little distinction is made in terminology. Chapter 9, Catalytic Hydrocracking and Hydroprocessing, contains a more detailed discussion of the properties of these fractions. Many investigators believe the asphaltenes are not in solution in the oil and resins but are very small, perhaps molecular size, solids held in suspension by the resins and there is a definite critical ratio of resins to asphaltenes below which the asphaltenes will start to precipitate. During the cracking phase some of the resins are cracked to lighter hydrocarbons and others are converted to asphaltenes. Both reactions affect the resin–asphaltene ratio, the resultant stability of the visbreaker tar product, and serve to limit the severity of the operation. The principal reactions [17] which occur during the visbreaking operation are: 1. Cracking of the side-chains attached to cycloparaffin and aromatic rings at or close to the ring so the chains are either removed or shortened to methyl or ethyl groups. Compounds which convert to asphaltenes. There is little cracking of naphthenic rings below 900 F (480°C). 2. Cracking of resins to light hydrocarbons (primarily olefins) and 3. At temperatures above 900 F (480 C), some cracking of naphthene rings. The severity of the visbreaking operation can be expressed in several ways: the yield of material boiling below 330 F (166

C), the reduction in product viscosity