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Two-stage coal hydrogenation process - with catalytic hydrogenation of suspended coal particles in mild first stage, and liquefaction in second

(c) gas and distillate prods.

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HYDROGENATION PROCESS CLAIMED

The continuous process comprises:

- (i) mixing coal particles (1 pt.) with a hydrogenated, coal-derived solvent (1.5-8 pts.), to give a fluid suspension;
- (ii) feeding the suspension with H₂ upwards through a first reaction zone (I) at about 200-370°C, contg. a particulate catalyst and H₂ at 7-140 bar, which hydrogenates the coal particles;
- (iii) removing suspension from (I) and feeding to a second reaction zone (II) at about 370-450°C, with particulate catalyst and H₂ at 0-140 bar, so converting the hydrogenated particles to gas and liq.; and
- (iv) leading prod. from (II) to a sepn. zone, for sepn. of
 - (a) a liq. of reduced solids content for use as solvent in step (i),
 - (b) a purified H₂ stream for supply to (I) and

ADVANTAGES

Reaction conditions need not be as severe as in conventional processes, and the gas and liq. yields are higher, e.g. the 4C-520°C prod. yield is 69% compared with 56% from the "H-Coal" process.

FEEDSTOCKS

Bituminous, subbituminous or brown coal or peat may all be used.

PREFERRED CATALYST

The catalyst in (I) and (II) may comprise Co/Mo, Ni/Mo; Li-, W- or Sn- activated Co/Mo; NiS, CoS, MoS, FeS, FeS₂; LiH, MgH₂; Group VIII metals and their salts, Sn, Zn, Cu, Cr or Sb, each on a porous or non-porous substrate. The catalyst beds may be pulsed, fluidised or ebullating.

PREFERRED CONDITIONS

The coal particles have particle size 0.84-0.03 (esp. 0.21-0.15) mm. The coal-derived solvent is largely of b.pt. 200-600°C, esp. with 50% having a b.pt. above about 520°C. A solvent oil derived from petroleum, shale oil, etc. may be used.

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The temp. is about 290°C in (I), and about 430°C in (II). The total pressure is about 7-280 bar in (I), and about 35-280 bar in (II). The reaction time is about 5-90 min. in (I) and about 1-90 min. in (II).

EXAMPLE

The same coal ("Burning Star Illinois No. 6") was liquefied,

(a) by the invention, with 30 min. residence in (I) at 290°C and 140 bar, and 30 min. residence in (II) at 430°C and 140 bar; and

(b) by the 1-stage H-Coal process, with 30 min. residence at 460°C and 160 bar.

Coal conversion was (a) 93.0%, (b) 94.0%; and H₂ consumption was (a) 4.6 wt.%, (b) 5.2 wt.%. Yields by b.pt. (wt. % on dry coal) included: 1-3C (a) 7.2, (b) 9.9; 4C-200°C, (a) 15.4, (b) 19.8; 200-340°C, (a) 19.8, (b) 18.6; 340-520°C, (a) 21.1, (b) 10.0; 520°C+, (a) 11.8, (b) 19.5. (42pp1492MHDwg No.0/6).