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(12) **Patent:** (11) **CA 619727**

(54) SYNTHESIS FURNACE FOR THE HYDROGENATION OF CARBON MONOXIDE IN A LIQUID MEDIUM

(54)

(72) (Country):	**HERBERT KOLBEL** (Not Available) **ROBERT LANGHEIM** (Not Available)
(73) (Country):	**RHEINPREUSSEN AKTIENGESELLSCHAFT FUER BERGBAU UND CHEMIE**
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The invention relates to a particular formation of the cooling elements in synthesis reactors for the hydrogenation of carbon monoxide in a liquid medium, by means of which the synthesis of the hydrocarbons proceeds under particularly advantageous conditions.

The dissipation of the heat evolved in the catalytic hydrogenation of carbon monoxide has probably always been the most difficult technical problem in this synthesis. Out of all the known methods of carrying out the hydrogenation of carbon monoxide the conditions most favourable in this respect are provided when the synthesis is carried out in a liquid medium. However, also in this case, where very active and highly loaded catalysts are used, overheating may occur when the cooling is insufficient, which generally results in a high formation of methane and separation of carbon, and consequently in a reduction in the yield and a shortening of the active life of the catalyst.

It has now been found that this overheating and, more particularly, the results thereof may be avoided if the cooling area of the cooling elements, based on the unit by volume of catalyst suspension, is reduced in the upward direction continuously or in stages. In practice this may be carried out in such manner that the cooling area of the cooling elements is reduced in the upward direction either continuously or in stages by combining, for example, two or more cooling tubes to form one cooling tube or a smaller number of cooling tubes (Figure 2), or by assembling the cooling system from several short cooling sets the cooling areas of which decrease upwardly in size as desired.

The invention is explained in detail with reference to the following comparative Examples:-

A vertical synthesis reactor of known kind having a height of 12 metres and a diameter of 1.40 metres contains 360 water-cooled tubes (Figure 1). In the hydrogenation of carbon monoxide carried out in this reactor in the presence of an iron catalyst, which forms predominantly low-boiling products (80% to 85% of the C_{3+} -hydrocarbons boil at below 200°C), in a 10% suspension (10% Fe), and with the synthesis gas rich in carbon monoxide as specified in the Table hereinafter given, a CO conversion of more than 90% at a temperature of 267°C in the cooling system is obtained, as will be noted from the end gas analysis I given in the Table. The performance of the catalyst amounts to approximately 400 kilograms of hydrocarbons per kilogram Fe.

According to the invention, when the number of cooling tubes at a position approximately 3 metres after the entry of the synthesis gas is reduced to 270, after a further 3 metres to 180, and finally after a further 3 metres to 90 (Figure 2), the results of the synthesis using the same catalyst and the same synthesis gas and the same load, are considerably more favourable as will be noted from the end gas analysis II in the Table. With a lower temperature in the cooling system, the CO conversion obtained is higher, and more particularly considerably less methane is formed. Moreover, the value of the unsaturated C_3+C_4 hydrocarbons is considerably increased. Moreover, the performance of the catalyst has risen by approximately 50% to 600 kilograms of hydrocarbon per kilogram Fe, due to the reduced formation of methane and the longer active life of the catalyst.

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	Temper. °C.	CO_2	C_3+C_4-olefins	C_2	CO	H_2	Hydrocarbons	N_2	CO conversion%	grams CH_4 per normal cbm. $CO+H_2$	grams C_3+ per normal cubic metre $CO+H_2$
Synthesis gas analysis		4.0	–	–	56.3	34.5	0.2	5.0	–	–	–
End gas analysis 1	267	59.4	3.1	0.7	9.4	11.2	6.2	10.0	91.8	21.2	157.8
End gas analysis 11	262	61.4	4.7	0.5	7.7	11.0	4.2	10.5	93.6	12.2	172.3

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A process for the production of hydrocarbons by the hydrogenation of carbon monoxide in the presence of a catalyst suspended in a liquid medium, including the step of cooling the catalyst suspension, the area of the cooling or heat transfer surface or surfaces per unit volume of the catalyst suspension being reduced in the direction of flow of the synthesis gas.

2. A process according to claim 1, in which the area of cooling or heat transfer surface or surfaces is reduced in stages in the direction of flow of the synthesis gas.

3. A process according to claim 1 or claim 2, in which the catalyst is an iron catalyst.

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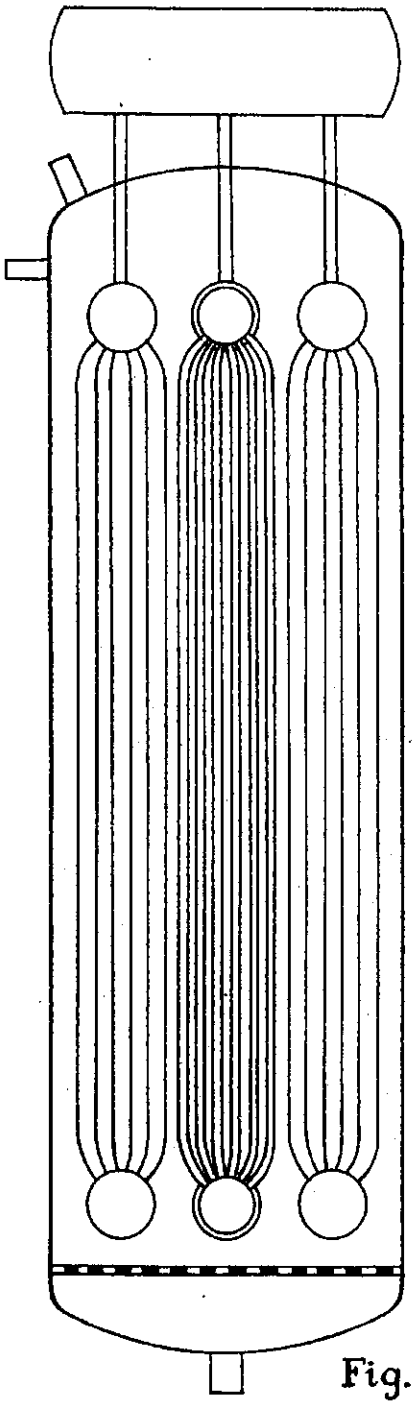

Fig. 1

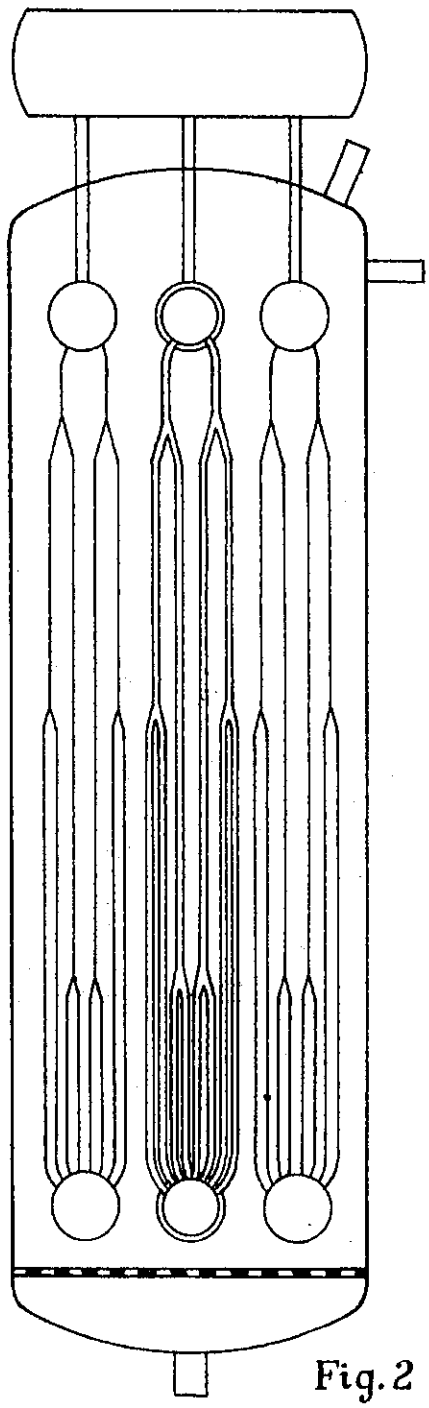

Fig. 2

INVENTORS
H. KOLBEL
R. LANGHEIM

PATENT ATTORNEYS
Ridout & Maybee