USE OF A CEMENTED CARBIDE FOR OIL AND GAS APPLICATIONS
ANWENDUNG EINES ZEMENTIERTEN KARBIDES FÜR ÖL- UND GASANWENDUNGEN
UTILISATION D'UN CARBURE METALLIQUE DANS DES APPLICATIONS D'HUILE ET GAZ

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: 30.06.1998 SE 9802324

(43) Date of publication of application:
16.05.2001 Bulletin 2001/20

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(56) References cited:
WO-A1-80/02569
WO-A1-92/13112

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The present invention relates to a cemented carbide grade with special properties for oil and gas applications. Moreover, the invention refers to the application of a corrosion-erosion resistant grade for choke valves to control the flow of multimedia fluid (gas, liquid, and sand particles).

Cemented carbide for corrosion resistance demanding applications such as seal rings, bearings, bushings, hot rolls, etc. generally has a binder phase consisting of Co, Ni, Cr, and Mo where the Cr and/or Mo act as corrosion inhibiting additions. An example of such a cemented carbide with a medium WC grain size is disclosed in EP 28 620. EP 568 584 discloses the use of a corrosion resistant cemented carbide with submicron WC grain size with excellent properties particularly for tools in the wood industry.

A critical component of subsea oil/gas production systems is the choke trim components, the primary function of which is to control the pressure and flow of well products. Under severe conditions of multi flow media, these components even when fitted with cemented carbide trims may suffer from extreme mass loss by exposure to solid particle erosion, acidic corrosion, erosion-corrosion synergy, and cavitation mechanisms.

The opportunity to maintain or replace such equipment in the field especially in offshore deep water sites is limited by weather conditions. It is therefore essential that reliable and predictable products form part of the subsea system.

The composition of the cemented carbide grades presently used for withstanding conditions of service in this environment generally consist of tungsten carbide (WC) as the hard component and cobalt (Co) or nickel (Ni) as the binder material to cement together the WC crystals.

To meet the demands of hardness and toughness, the amount of binder and/or the WC grain size are varied and cobalt is generally accepted as the optimum binder constituent. Where corrosion is the predominant factor then the binder material is usually of nickel or nickel+chromium (Ni+Cr) composition.

Analogous to stainless steels Cr and Ni alloys have improved passivity by reducing the critical currents involved in corrosion, however (Cr+Ni) are not so resistant to halides (seawater) or inorganic acids. For these conditions the addition of molybdenum gives improved corrosion resistance in addition to improving binder strength of Ni.

Recent experimental work including field trial evaluation has proven that in cases of high erosion conditions under a corrosion media then the mechanism of mass loss is a combination of each condition but moreover synergistic.

The present invention relates to the use of cemented carbide with excellent properties regarding resistance to the combined erosion and corrosion synergistic effects at temperatures between -50 and 300°C, preferably 0-100°C.

In one preferred embodiment the cemented carbide has the composition 3.3 % Co, 1.1 % Ni, 0.52 % Cr, 0.1 % Mo with the balance of WC with an average grain size of 0.8 µm. The cemented carbide has the composition, in wt%, 2.5-4.5 Co+Ni with a weight ratio Co/Ni of about 3, 0.25-0.6 Cr and about 0.1 Mo.

In another preferred embodiment the composition is 1.9 % Co, 0.7 % Ni, 0.3 % Cr, 0.1 % Mo with the balance of WC of 0.8 µm.

The carbon content within the sintered cemented carbide must be kept within a narrow band in order to retain a high resistance to corrosion and wear as well as toughness. The total carbon content shall be in the interval of 6.13-(0.061+0.008) x binder phase (Co+Ni) content (wt-%), preferably 6.13-(0.061+0.005).

The cemented carbide used in this invention is manufactured by conventional powder metallurgical methods milling, pressing shaping and sinterhipping.

Example 1

A cemented carbide according to the invention had the composition 3.3 % Co, 1.1 % Ni, 0.6 % Cr3C2, 0.1 % Mo with the balance of WC, a hardness of 1900 HV30 and transverse rupture strength (TRS) of 2350 N/mm² with a mean WC grain size of 0.6 µm. It was tested against commercially available cemented carbide grades one made from 6 % Co and the other from 6 % Ni both with the balance of WC (0.8 µm) under the following simulated test conditions:

- synthetic seawater
- sand 18 m/s
- CO2 1 Bar
- temperature 54°C.
The following results were obtained. Units material loss: mm/year

<table>
<thead>
<tr>
<th>Grade</th>
<th>corrosion</th>
<th>erosion</th>
<th>synergistic</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC 6%Co</td>
<td>0.02</td>
<td>0.09</td>
<td>0.35</td>
<td>0.46</td>
</tr>
<tr>
<td>WC 6%Ni</td>
<td>0.015</td>
<td>0.265</td>
<td>0.17</td>
<td>0.45</td>
</tr>
<tr>
<td>invention</td>
<td>0.015</td>
<td>0.06</td>
<td>0.025</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Example 2

Cemented carbides were made according to the invention with the composition 3.3 % Co, 1.1 % Ni, 0.6 % Cr₃C₂, 0.1 % Mo with the balance of WC 0.8 μm, referred to as grade 1 and grade 2 consisting of a similar alloy composition but with reduced proportions of 1.9 % Co, 0.7 % Ni, 0.35 % Cr₃C₂, 0.1 % Mo with the balance of WC. These materials had hardness values of 1900HV30 and 1910HV30 and transverse rupture strength (TRS) of 2350 N/mm² and 2350 N/mm² respectively each with a mean WC grain size of 0.6 μm. They were tested against commercially available cemented carbide grades under the following simulated test conditions of seawater and sand.

Flow rate: 90 m/sec and impingement angles of 30° and 90°.

Example 3

A cemented carbide according to the invention with the composition 3.3 % Co, 1.1 % Ni, 0.6 % Cr₃C₂, 0.1 % Mo, with the balance of WC and a hardness of 1900HV30 and transverse rupture strength (TRS) of 2350 N/mm² with a mean WC grain size of 0.6 μm was tested against commercially available cemented carbide grades. Test conditions of air and sand at 200 m/s:

Flow rate: 200 m/s air and impingement angles of 30° and 90°.

Example 4

The cemented carbide according to the invention shows significant reduction in wear as measured by volume loss.

Claims

1. Use of a cemented carbide containing, in wt%, 2.5-4.5 Co+Ni with a weight ratio Co/Ni of about 3, 0.25-0.6 Cr and 0.1 Mo wherein essentially all of the WC grains have a size <1 μm and wherein the total carbon content is in the interval of 6.13-(0.061+0.008) x binder phase (Co+Ni) content (wt-%) for oil and gas applications particularly for components, the primary function of which is to control the pressure and flow of well products at temperatures between -50 and 300°C, preferably 0-100°C.

2. Use of a cemented carbide according to claim 1 containing in wt-% 3.3 % Co, 1.1 % Ni, 0.52 % Cr, 0.1 % Mo with balance of WC.

3. Use of a cemented carbide according to claim 1 containing in wt-%1.9 % Co, 0.7 % Ni, 0.3 % Cr, 0.1 % Mo with
4. Use of a cemented carbide according to any of the preceding claims with a total carbon content in the interval of 6.13-(0.061±0.005) x binder phase (Co+Ni) content (wt.%).

Patentansprüche

1. Verwendung eines Hartmetalls, das in Gewichtsprozenten 2,5 bis 4,5 Co + Ni mit einem Gewichtsverhältnis Co/Ni von etwa 3,0 bis 0,6 Cr und 0,1 Mo enthält, worin im wesentlichen die gesamten WC-Körner eine Größe von <1 µm haben und der Gesamtkohlenstoffgehalt im Bereich von 6,13 - (0,061 ± 0,008) x Bindemittelphasengehalt (Co + Ni) (Gewichtsprozente) für Öl und besonders für Gasanwendungen für Bestandteile liegt, deren Primärfunktion darin besteht, den Druck und den Fluß von Produkten bei Temperaturen zwischen -50 und 300 °C, vorzugsweise 0 bis 100 °C, zu steuern.

2. Verwendung eines Hartmetalls nach Anspruch 1 mit einem Gehalt in Gewichtsprozenten von 3,3 % Co, 1,1 % Ni, 0,52 % Cr, 0,1 % Mo und Rest WC.

3. Verwendung eines Hartmetalls nach Anspruch 1 mit einem Gehalt in Gewichtsprozenten von 1,9 % Co, 0,7 % Ni, 0,3 % Cr, 0,1 % Mo und Rest WC.

4. Verwendung eines Hartmetalls nach einem der vorausgehenden Ansprüche mit einem Gesamtkohlenstoffgehalt im Bereich von 6,13 - (0,061 ± 0,005) x Bindemittelphasegehalt (Co + Ni) (Gewichtsprozente).

Revendications

1. Utilisation d'un carbure cémenté contenant, en % pondéral, 2,5 à 4,5 de Co+Ni avec un rapport pondéral de Co/Ni d'environ 3,0 à 0,6 de Cr et 0,1 de Mo, dans lequel essentiellement tous les grains de WC ont une taille inférieure à 1 µm et dans lequel la teneur totale en carbone est dans l'intervalle de 6,13-(0,061±0,008) x teneur en phase liante (Co+Ni) (% en poids) pour des applications huileuses et gazeuses en particulier pour des composants, dont la fonction principale est de réguler la pression et l'écoulement de produits de puits à des températures comprises entre -50°C et 300°C, de préférence, entre 0°C et 100°C.

2. Utilisation d'un carbure cémenté selon la revendication 1, contenant, en % pondéral, 3,3% de Co, 1,1% de Ni, 0,52% de Cr, 0,1% de Mo, le complément étant WC.

3. Utilisation d'un carbure cémenté selon la revendication 1, contenant, en % en poids, 1,9% de Co, 0,7% de Ni, 0,3% de Cr, 0,1% de Mo, le complément étant WC.

4. Utilisation d'un carbure cémenté selon l'une quelconque des revendications précédentes avec une teneur totale en carbone dans l'intervalle de 6,13-(0,061±0,005) x teneur en phase liante (Co+Ni) (% en poids).