

# THE BEHAVIOUR OF MOLYBDENUM ELECTRODE IN SULPHATE-REFINED GLASS MELT

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*The extent of corrosion and the composition of both condensed and gaseous reaction products on the molybdenum electrode in a model glass melt with an approximate composition of 74 SiO<sub>2</sub>, 10 CaO, 16 Na<sub>2</sub>O and 0.5 SO<sub>3</sub> (wt.%) were investigated in terms of the electrode potential and loading by alternating current at 1400°C. At the rest corrosion potential, probably a liquid layer of Mo<sub>2</sub>S<sub>3</sub> is formed on the electrode. In the course of the corrosion process, molybdenum is probably introduced into the glass melt as Mo(III). No development of SO<sub>2</sub> was established under these conditions. An intimation of passivation and appearance of oxygen compounds of molybdenum begin at a potential increased by 200 mV. The passivation is interfered with by development of SO<sub>2</sub> on the electrode, which starts already at a potential raised by 300 mV, and is probably originated by electrochemical oxidation of sulphate anions. The corrosion rate thus increases again with increasing potential. The oxidation of molybdenum stops when the potential has been reduced by about 200 mV. The depolarizing reaction was suppressed at the same time. Beginning of the penetration of silicon into the electrode was recorded at potentials decreased by 400 mV. Further reduction of the potential resulted in the formation of MoSi<sub>x</sub> layers and in the liberation of hydrogen, which, however, was rapidly oxidized by the glass melt. The corrosion rate is virtually unaffected by alternating current with a density of 1 A/cm<sup>2</sup>. No electrochemical separation of gas on the electrode takes place at loadings of up to 5 A/cm<sup>2</sup>. The increased formation of bubbles in glass melt in the neighbourhood of the electrode is a result of overheating of the glass melt by the liberated heat.*

## INTRODUCTION

Glasses refined with sulphate belong among the most frequently manufactured ones. Sulphate is known [1-5] as a depolarizer of molybdenum corrosion and the corrosion increases with its increasing content in the melt. However, with the currently employed amounts of up to several tenths of percent by weight the corrosion of heating electrodes is sustainable and the electrodes need not be necessarily protected. This is also why the corrosion behaviour in glass melts containing sulphur oxide has so far been paid comparatively little attention, in particular with respect to possible suppression of the corrosion.

However, even restricted corrosion represents a loss of valuable material and its suppression makes sense unless it requires expensive equipment. Oxidation of the material, as a primary cause of corrosion, also involves penetration of sulphur, in the form of sulphide,

between the grains of the metal. This is responsible for embrittlement [4,6] and possible fracturing of the electrodes. Considerable amounts of sulphate ions may be present in melts resulting from vitrification of radioactive waste materials. In some instances (refining by a combination of antimony oxide and sulphate, some coloured glasses) it is desirable to suppress precipitation of the metal. In principle this is always possible by shifting the potential to adequately positive values. However, if the passive state cannot be achieved, the corrosion rate may significantly increase [7]. This is why it is desirable to know the behaviour of electrodes in dependence on their potential.

Relatively little work has been devoted to the study of reaction products in sulphate-containing glass melts. All of the respective studies jointly mention formation of molybdenum sulphides apart from SO<sub>2</sub> [2,4,5] and Na<sub>2</sub>MoO<sub>4</sub> [1,5]. In the case of sulphide, mention is sometimes made of MoS<sub>2</sub> [1, 3-5]. These results are

mostly based on X-ray diffraction analyses of cooled-down samples. However, Hierl, Hanke and Scholze [4] point out an unsatisfactory agreement of their patterns with tabulated data. The formation of SO<sub>2</sub> as the primary reaction also cannot be regarded as fully proven, particularly when Boffe et al. [2] consider the possibility of a subsequent oxidation of the released molybdenum sulphides by the sulphate contained in the glass melt, yielding SO<sub>2</sub>.

None of the studies quoted [1-5] examined the behaviour of the molybdenum electrodes in terms of the electrode potential. Study [7] was concerned in this way with the behaviour of the molybdenum electrode in a glass melt being refined by a combination of antimony oxide and sulphate. On this occasion it was found that at the increased potential the electrode in the melt exhibited an indication of passivation, followed by continued and permanent increased corrosion when the potential was further increased. This result is indicative of possible interference with passivation in the presence of sulphate.

The present study had the aim to examine the effect of electrode potential and that of alternating current on the scope of corrosion and on the character of reaction products on the molybdenum electrode in a sulphate-refined glass melt.

## EXPERIMENTAL

The behaviour of the molybdenum electrode was examined under laboratory conditions in a glass melt having the composition 73.64 % SiO<sub>2</sub>, 9.95 % CaO, 15.92 % Na<sub>2</sub>O, 0.49 % SO<sub>3</sub> (wt.%) at 1400°C. The glass was melted from sodium carbonate, calcium carbonate and sodium sulphate of A.R. purity, and glassmaking sand with a minimum content of 99.3 % SiO<sub>2</sub>. The composition of the glass was checked by X-ray fluorescence analysis. The working electrodes and the auxiliary ones were prepared from annealed molybdenum wire 1.2 mm in diameter, manufactured by Plansee AG. The molybdenum wire was protected by a capillary tube of quartz glass. Its unprotected part constituted the working area of the electrode. The reference electrode was represented by platinum wire of 1mm diameter, passing freely through the melt surface to a depth of about 5 mm in the glass melt. The electrodes were passed vertically into a crucible with the molten glass, placed in an electrically heated furnace.

The "stationary" polarization curves together with the scope of corrosion at the given potential were measured jointly in three-electrode arrangement with the working, auxiliary and the reference electrodes. The working electrode was 20 mm in length and its surface area was 0.765 cm<sup>2</sup>. The necessary larger areas of the

auxiliary electrode were achieved by its double or triple folding over a length of 20 mm. The crucible contained 68 g of glass melt. The potential was maintained at the required value for a period of 7 hours by means of potentiostat. Immediately after introduction into the glass melt the electrodes were connected to the potentiostat and the time metering was also started. The potential required was set with respect to the previously measured constant steady value that amounted to -704 mV. The "stationary" polarization curves were obtained from the dependence of the mean value of the current passing through the circuit of the auxiliary electrode, obtained by integrating its time course in terms of the electrode potential. Since the mean current values also include the initial period, the stationary polarization curves are not exactly what they should be by definition but have the advantage of allowing for a comparison of the mean current values with the those of corrosion, which likewise include the initial period. Following conclusion of the experiment, the temperature was quickly reduced to about 1250°C and the electrodes with the layer of adhering glass were withdrawn from the melt. After casting in epoxy resin the working electrode was cut perpendicularly to its axis, producing slices about 3mm thick, and subsequently lapped with fine emery paper. The diameters were then measured under the microscope. The loss in diameter (radius) was calculated as the difference between the mean values for cuts in the respective protected and unprotected parts of the electrode.

Measurement of corrosion under the effect of alternating current was carried out on pairs of identical working electrodes. The electrodes were fed with a current of mains frequency (50 Hz) from a simple circuit containing a control transformer, an adjusting one and a stabilizing resistor of 13.4 Ohm. The experiments took again seven hours each. The corrosion losses were evaluated in the same way as in constant potential measurements, while calculating the mean losses for both electrodes.

The condensed reaction products at the interface of the molybdenum electrode and the glass were studied by optical microscopy and by backscattered electron microscopy. Selected points were subjected to quantitative analysis by the Cameca SX-100 microprobe, using crystal monochromators allowing the coincidence of molybdenum and sulphur lines to be ruled out. The polished sections were prepared from the cuts on which the corrosion losses have been evaluated. In some instances use was made of specially prepared specimens in which the electrodes were left behind in the glass melt that was allowed to cool down freely in the switched-off furnace.

The development of bubbles in terms of potential and alternating current loading was studied on electrodes placed in the glass melt in a silica glass cell with

approximately plan parallel walls. The arrangement and feeding of the electrodes was similar to the case described above. The cell was placed in a special furnace allowing observation against a dark background, described e.g. in [8]. The processes taking place at the electrode were scanned by a TV camera and evaluated from a recording speeded up 80 times. Following 2.5-hour holding at the rest corrosion potential the potential was changed at half-hour intervals, as a rule by steps of 100 mV each. The alternating current loading was increased at intervals of 20 minutes.

The specimens were prepared for analyses of the bubble contents in the way described above, except that the working parts of the electrodes were bent into horizontal position and placed as close to the crucible bottom as possible. Following introduction of the electrodes into the glass melt the system was kept at rest for two hours. Then the electrodes were connected alternatively to the potentiostat, or to an AC source, or the temperature was raised. The bubbles were allowed to develop for 5 to 10 minutes, and then the furnace temperature was rapidly reduced down to about 600°C (by moving the furnace). The bubbles formed during the initial period were also analyzed for the sake of comparison. The bubbles were cut out and analysed by means of type In-process Instruments GIA 522 mass spectrometer by the firm Glass Service Inc., Vsetín.

## RESULTS AND DISCUSSION

The results of measuring the corrosion losses and the overall current passing through the electrode in terms of potential, obtained under stationary conditions, are listed in table 1. The Table also shows the corrosion loss under an AC load of 1 A/cm<sup>2</sup> density. One can see that the corrosion is virtually unaffected by alternating current of the given density. This is in agreement with the conclusions reached for a similar glass by Hierl, Hanke and Scholze [4].

The dependence of corrosion losses expressed as current density of the corrosion current for Mo (III) and Mo (VI) vs. the potential, jointly with the similar dependence of overall current ("stationary" polarization curve) are plotted in figure 1 (mean values have been plotted for repeated measurements for the sake of lucidity). Both the corrosion and the overall current obviously attain the maximum values at 200 and 300 mV, respectively, in terms of corrosion potential; then a certain decrease takes place, but from 400 mV upwards both currents again show a distinct increase. From 300 mV upwards the overall current is higher than that calculated from the corrosion rate. This indicates that an additional process takes place apart from oxidation of molybdenum. In the same way as established earlier in a glass melt containing Sb<sub>2</sub>O<sub>3</sub> + SO<sub>3</sub> [7], the maximum

Table 1. The mean value of overall current  $i$ , the corrosion loss  $\Delta r$ , the calculated corrosion currents  $i_{Mo}$  and the rate of the depolarization process  $i-i_{Mo}$  in terms of the electrode potential.

$\Delta\epsilon$ (mV)	$i$ (mA/cm <sup>2</sup> )	$\Delta r$ ( $\mu\text{m}$ )	$i_{Mo}$ (mA/cm <sup>2</sup> )		$i-i_{Mo}$ (mA/cm <sup>2</sup> )	
			Mo (VI)	Mo (III)	Mo (VI)	Mo (III)
500	25.0	72	17.5	8.75	+7.5	+16.25
400	13.5	41	10.0	5.0	+3.5	+8.5
300	14.4	44	10.7	5.35	+3.7	+9.05
200	8.0	55	13.3	6.65	-5.3	+1.35
100	4.6	33	8.1	4.05	-3.5	+0.55
0	0.0	24	5.9	2.95	-5.9	-2.95
0	0.0	25	6.2	3.1	-6.2	-3.1
0	0.0	19	4.7	2.35	-4.7	-2.35
0*	-	21	-	-	-	-
-100	-2.6	9	2.2	1.1	-4.8	-3.7
-200	-5.5	0	0	0	-5.5	-5.5
-300	-3.6	0	0	0	-3.6	-3.6
-300	-4.2	0	0	0	-4.2	-4.2
-400	-14.0	0	0	0	-14.0	-14.0
-600	-39.6	0	0	0	-39.6	-39.6

\*) Loading by an alternating current of 1 A/cm<sup>2</sup>.

of the corrosion current occurs at a lower potential than the maximum of the overall current. This will be discussed further on.

Analysis of the condensed products at the electrode - glass melt boundary revealed the presence of a continuous layer of reaction product in the rest state (figure 2). Such a layer was only found on an electrode that has been cooled down freely in the glass melt. An electrode drawn out from the crucible jointly with a layer of adhering glass melt at about 1250°C was found to contain only rests of a discontinuous layer and crystals in the glass. This indicates that at the experimental temperature the layer of the reaction product is liquid. Quantitative analysis of the layer by the electron microprobe showed that the composition of the layer corresponds well to the compound  $\text{Mo}_2\text{S}_3$  (table 2).

At a potential increased by 200 mV the electrode-glass interface was found to contain an inhomogeneous layer composed of molybdenum and sulphur, as well as reaction products consisting mostly of molybdenum and oxygen. At a potential increased by 400 mV there were reaction products of two types, containing molybdenum and oxygen on the one hand, and molybdenum, oxygen and sodium on the other (table 3). Table 4 lists the composition of reaction products formed at reduced potentials: No reaction products were found on the electrode at a potential reduced by 200 and 400 mV, except for some silicon in the material at the edge of the electrode at a potential reduced by 400 mV (points 1 and 2). A comparison with the analysis of a point at the centre of the electrode (point 3) indicates that this did not involve a background, nevertheless, contamination of the damaged material near to the electrode-glass boundary by glass during preparation of the polished section cannot also be fully excluded. Additional reduction of the potential by 600 mV brought about formation of a layer of reaction product composed of Mo and Si, and of a layer with a lower concentration of silicon that was growing into the electrode interior (figure 3). This fact supports the possibility that diffusion of silicon into the electrode actually takes place already at a potential reduced by 400 mV.

Direct observation of the development of bubbles in terms of potential revealed that at a potential increased by up to 200 mV the electrode retains bubbles formed immediately after immersion of the electrode in the melt. At the given potential the original bubbles were released and continuous development of new bubbles started at a potential increased by about 300 mV in terms of the rest potential, and the development of the bubbles went on with further increase of potential and did not stop at a potential raised by as much as 2000 mV. Reduction of potential with respect to the rest potential likewise resulted in the formation of bubbles. The first bubbles started to appear at a potential reduced

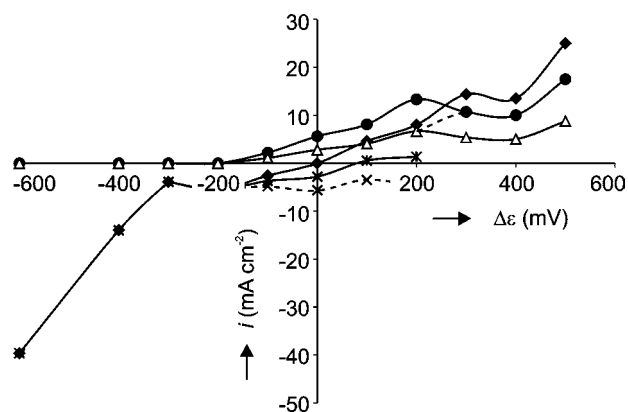


Figure 1. Dependence of overall, corrosion and depolarization current on electrode potential.  $\blacklozenge$  - overall current  $i$ ,  $\bullet$  - corrosion current  $i_{\text{Mo}}$  for Mo (VI),  $\triangle$  - corrosion current  $i_{\text{Mo}}$  for Mo(III),  $\times$  - depolarization current  $i-i_{\text{Mo}}$  for Mo (VI),  $*$  - depolarization current  $i-i_{\text{Mo}}$  for Mo (III).

Table 2. Composition of the sulphidic layer at rest potential (wt.%). The designation of the points corresponds to that in figure 2 (point 5 and 6 are beyond the figure).

element	composition at points 1-3, 5,6			theoretical composition of $\text{Mo}_2\text{S}_3$
	Range	Mean value	Mo + S	
Na	1.69 - 2.41	2.14	-	-
Si	0.02 - 0.78	0.25	-	-
S	30.14 - 32.24	31.51	32.56	33.39
Ca	0.07 - 0.31	0.14	-	-
Mo	63.55 - 67.56	65.26	67.44	66.61
O	0.00 - 1.65	0.824	-	-

Table 3. Composition of products at potentials increased by 200 and 400 mV (wt.%).

element	+200 mV		+400 mV		theoretical composition of	
	point		point		$\text{Na}_2\text{MoO}_4$	$\text{MoO}_2$
	1	2	1	2		
Na	3.47	0.69	14.40	0.38	22.33	-
Si	0.27	3.99	0.55	0.11	-	-
S	26.03	2.36	2.33	3.36	-	-
Ca	0.98	0.66	0.13	0.03	-	-
Mo	62.87	38.46	49.12	73.43	46.59	74.99
O	6.38	53.84	33.46	22.70	31.08	25.01

by 500 mV within about five minutes. A potential reduction by 600 mV produced formation of large bubbles about 2 mm in diameter at the electrode. However, these bubbles grew very slowly and only rarely were separated from the electrode.

The composition of gas developed inside the bubbles under the various conditions is listed in table 5. The bubbles formed under the effect of alternating current and by increased temperature had an almost identical internal composition, consisting mostly of SO<sub>2</sub>, CO<sub>2</sub> and N<sub>2</sub>. The chosen increase in temperature corresponded to the effect of loading the electrodes with alternating current of a density of 5 A/cm<sup>2</sup>. In both instances the bub-

bles were obviously formed in the glass melt by the refining process, during which the primary bubbles produced by thermal decomposition of sulphate, yielding SO<sub>2</sub> + O<sub>2</sub>, absorb the gases dissolved in the glass melt and give up their oxygen. On the other hand, the bubbles formed at a potential increased by 500 mV consist almost entirely of sulphur dioxide. Direct observation shows that the bubbles formed at potentials increased by 300 mV and more are probably produced by an electrochemical reaction at the electrode. During preparation for analysis of bubbles formed at a potential reduced by 600 mV, the results of direct observation of the development of bubbles have been proved correct: Numerous

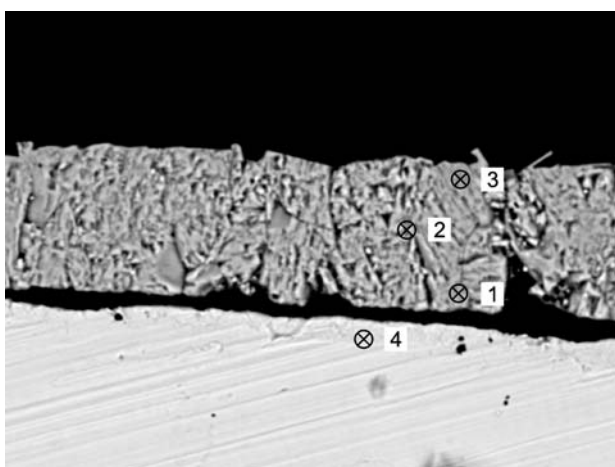


Figure 2. Electrode-glass melt boundary at rest potential under backscattered electrons (composition). Freely cooled sample. Quantitative analysis carried out at the indicated points (cf. table 2).

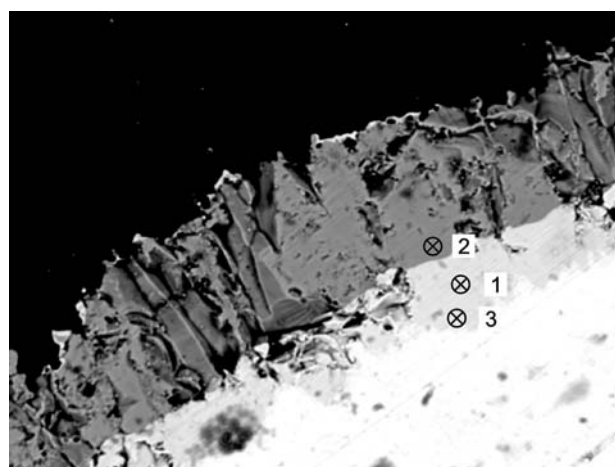


Figure 3. Electrode-glass melt boundary under a potential reduced by 600 mV, under backscattered electrons (composition). Quantitative analysis carried out at the indicated points (cf. table 4).

Table 4. Composition of products at a potential reduced by 400 and 600 mV, and a comparison with the composition at the electrode edge at rest potential in wt.%. The designation of points for -600 mV and ±0 mV corresponds to that in figures 3 and 2.

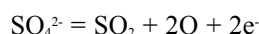
element	-400 mV			-600 mV			0 mV	theoretical composition of MoSi <sub>2</sub>
	point 1	point 2	point 3	point 1	point 2	point 3	point 4	
Na	0.00	0.04	0.00	0.11	0.02	0.03	0.01	-
Si	0.12	0.69	0.00	14.88	36.63	14.98	0.1	36.93
S	0.02	0.00	0.00	3.595	3.00	3.485	4.68	-
Ca	0.06	0.16	0.06	0.02	0.01	0.01	0.11	-
Mo	99.27	99.11	99.94	82.22	62.32	82.83	93.40	63.07
O	0.53	0.00	0.00	0.00	0.00	0.00	1.69	-

Table 5. Composition of gases in bubbles formed under various conditions (vol.%).

conditions	N <sub>2</sub>	CO <sub>2</sub>	Ar	SO <sub>2</sub>	H <sub>2</sub> S	COS
~5 A/cm <sup>2</sup>	15.4	29.4	-	54.7	-	0.5
+25°C	15.3	33.0	-	51.7	-	-
+500 mV	0.1	0.9	-	99.0	-	-
-600 mV	22.7	74.0	0.5	-	2.0	0.8

large (and damaged) bubbles about 2 mm in diameter in contact with the electrode were observed, very similar to those observed directly. Only a single bubble 1 mm in diameter and containing H<sub>2</sub>S was found at a little distance as 3 mm from the electrode (table 5). Bubbles less than 1 mm in diameter were found in still higher positions. The time lag of several minutes between setting the potential and the beginning of bubble development was also confirmed.

On the basis of the established composition of both condensed and gaseous reaction products, the behaviour of the molybdenum electrode in terms of potential can be interpreted as follows: The Mo<sub>2</sub>S<sub>3</sub> sulphide, arising at the rest potential, is probably further dissolved or released into the glass melt. During the corrosion process, molybdenum is thus oxidized to Mo(III) (this of course does not rule out additional oxidation of the reaction products by the ambient glass melt). Table 1 lists the corrosion currents calculated for oxidation to Mo(III) and to Mo(VI). At the same time, there are given the differences between the corrosion and overall currents, which should correspond to the rate of the depolarizing reaction in the proximity of the corrosion potential. The values are plotted in figure 1. One can see that the course of the depolarizing reaction rate calculated for Mo(III) corresponds to the expectation, where the depolarizing reaction stops at a potential increased by about 100 mV. If in this region one would consider oxidation to Mo(VI), this would lead to an improbable increase in the depolarization rate towards more positive values (dotted course in figure 1). Starting with potentials increased by 200 - 300 mV, the character of the reaction products undergoes a change: The content of sulphide decreases, being replaced by oxygen compounds of molybdenum containing Mo(IV) and Mo(VI). On considering this change of molybdenum valency beginning at a potential raised by 200 mV, it is possible, by joining the two calculated courses of corrosion current in terms of potential (as indicated by the dashed line in figure 1), to attain a course whose maximum corresponds to the maximum of overall current passing through the electrode. The onset of formation of oxygen-containing reaction products corresponds to an intimation of passivation of the material. This passivation is interfered with by the development of gas at a potential increased by 300 mV. As the bubbles formed were found to contain only SO<sub>2</sub>, electrochemical oxidation of the SO<sub>4</sub><sup>2-</sup> anions:



appears as the most probable one, where the oxygen is bound by oxidation of molybdenum

The decrease of potential probably involves reduction of alkaline ions and subsequent separation of silicon, which diffuses into the electrode. Only further

reduction of the potential leads to the formation of the MoSi<sub>x</sub> layer on the electrode. This is in agreement with the report by Vander Poorten et al. [9]. The presence of a layer of silicide is probably a precondition for the onset of another electrochemical reaction, namely evolution of gas. And this is probably the cause of the time gap (mentioned above) between the setting of the potential and the actual development of gas. At the given potential, on the electrode, OH groups are probably reduced to hydrogen, which, however, is immediately oxidized in contact with the glass melt by sulphur compounds, producing H<sub>2</sub>S and water. Also this agrees with the established composition of gas in the bubble and with the findings by Nĕmec and Kloužek [10], according to which hydrogen and sulphur dioxide cannot co-exist in a bubble. A similar behaviour was observed in hydrogen bubbles formed by chemical reduction of glass melt by silicon compounds [11]. Hydrogen was found only in glass melt free from SO<sub>3</sub>, whereas glass melts containing several tenths percent of sulphate had bubbles with compositions similar to those in table 5.

There is the remarkable fact that in the region of potentials reduced by 200 mV and more, even separation of sulphide was found to be suppressed. Suppression of the depolarising reactions at potentials reduced by a few hundred mV is probably a more general phenomenon. Suppression of lead separation from lead glass melts containing 24 wt.% PbO [12,13] was described, and separation of antimony from glass melts refined with antimony oxide [7] is probably likewise suppressed in this region. In view of the introduction of cathodic protection of electrodes and with respect to the function of auxiliary electrodes in anodic protection the subject matter of this behaviour should certainly deserve more detailed study.

## CONCLUSIONS

1. At the rest potential, a liquid layer of Mo<sub>2</sub>S<sub>3</sub> is probably formed on the molybdenum electrode in a glass melt refined with sulphate. In the course of the spontaneous corrosion process, the molybdenum is probably converted or released from the electrode into the glass melt as Mo(III) and the sulphate is reduced to sulphide. Under these conditions, no development of SO<sub>2</sub> on the electrode has been confirmed.
2. At a potential increased by 200 mV there occurs an intimation of passivation involving generation of oxygen-containing compounds of Mo(IV) and/or Mo(VI). The passivation is interfered with by massive development of SO<sub>2</sub> on the electrode, which already starts at a potential raised by 300 mV and is probably originated by electrochemical oxidation of SO<sub>4</sub><sup>2-</sup> ions. The corrosion rate therefore further increases with increasing potential.

3. At a potential reduced by about 200 mV the oxidation of molybdenum is stopped while the depolarizing reaction is simultaneously suppressed. Starting with potentials reduced by 400 mV and more, penetration of silicon into the electrode was indicated. Further reduction of potential resulted in the formation of MoSi<sub>x</sub> layers and in liberation of hydrogen, which, however, was readily oxidized by the glass melt. The behaviour of the molybdenum electrode in the cathodic region deserves further research.
4. Alternating current with a density of 1 A/cm<sup>2</sup> does not virtually affect the corrosion rate. Gas is not evolved electrochemically at the electrode up to a current loading of 5 A/cm<sup>2</sup>. The more extensive formation of bubbles in the glass melt in the neighbourhood of electrodes is a result of glass melt overheating by the liberated heat which promoted decomposition of the sulphate.
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#### CHOVÁNÍ MOLYBDENOVÉ ELEKTRODY VE SKLOVINĚ ČEŘENÉ SULFÁTEM

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Velikost koroze a složení kondenzovaných i plyných reakčních produktů na molybdenové elektrodě v modelové sklovině o přibližném složení 74 SiO<sub>2</sub>, 10 CaO, 16 Na<sub>2</sub>O a 0,5 SO<sub>3</sub> (hmot.%) byly vyšetřovány v závislosti na potenciálu elektrody a zatížení střídavým proudem při teplotě 1400°C. Při křidovém korozním potenciálu se na elektrodě vytváří pravděpodobně kapalná vrstva sulfidu Mo<sub>2</sub>S<sub>3</sub>. Molybden je v korozním procesu pravděpodobně převáděn do skloviny jako Mo(III). Vývoj SO<sub>2</sub> za těchto podmínek nebyl potvrzen. Při potenciálu zvýšeném o 200 mV se objevuje náznak pasivace a výskyt kyslíkatých sloučenin molybdenu. Pasivace je narušena vývojem SO<sub>2</sub> na elektrodě, který začíná již při potenciálu zvýšeném o 300 mV a má pravděpodobný původ v elektrochemické oxidaci síranových aniontů. Rychlost koroze proto se zvyšujícím se potenciálem dále roste. Při snížení potenciálu o asi 200 mV se oxidace molybdenu zastavuje. Současně je potlačena i depolarizační reakce. Od potenciálu sníženého o 400 mV byl zaznamenán náznak pronikání křemíku do elektrody. Další snižování potenciálu má za následek tvorbu vrstev MoSi<sub>x</sub> a vylučování vodíku, který je však sklovinou rychle oxidován. Střídavý proud o hustotě 1 A/cm<sup>2</sup> rychlost koroze prakticky neovlivňuje. Až do zatížení 5 A/cm<sup>2</sup> nedochází k elektrochemickému vylučování plynu na elektrodě. Zvýšená tvorba bublin ve sklovině v okolí elektrody je důsledkem přehřátí skloviny vybaveným teplem.