Cr-1Mo and 9Cr-1Mo ferritic steels are important commercial alloys among the various alloys used for high temperature applications. One of the requirements for high temperature application is oxidation-resistance. In the present work, an attempt has been made to study the oxidation kinetics of the standard 2Cr-1Mo steels and 9Cr-1Mo steels and their stabilized varieties, in air and oxygen using long term experiments at the temperatures of actual operation and using accelerated tests (i.e. at temperatures much higher than the actual temperature of operation). Short term experiments have also been carried out in steam using a special atmosphere furnace, which can continuously record the weight changes as a function of time. The effect of prior cold work on the oxidation resistance of these alloys has also been investigated.

Oxidation resistance of 2Cr-1Mo steels has been described by the formation of a protective mixed oxide layer up to 800°C. Kinetics follow more or less parabolic law for 2Cr-1Mo steel, while it follows a logarithmic law for 2Cr-1Mo-Nb steel in the protective range. At 9000°C and above the steels undergo breakaway oxidation. Oxidation of the stabilized steel is slower than that of the standard 2Cr-1Mo steel. The former had however, greater tendency to spall.

Out of the three 9Cr-1Mo steels studied viz., 9Cr-1Mo (high Si), 9Cr-1Mo (low Si) and 9Cr-1Mo-Nb steels, the stabilized variety was found to be the best in terms of oxidation resistance and the 9Cr-1Mo (low Si), the worst. Up to 600°C, the oxidation resistance was provided by a mixed oxide of chromium and iron, but at 700°C and above, Cr was...
selectively oxidising to form a Cr$_2$O$_3$ layer. This was confirmed by AES, ESCA results. Due to the switch-over from general oxidation at 600°C to selective oxidation at 700°C, the oxidation rate was lower at 700°C than at 600°C. This has been confirmed by the long term oxidation results in air for all the three steels. All the three steels follow nearly a logarithmic law up to 800°C except for the low-Si alloy at 600°C. The initial rapid rate, slows down to almost nil rate. At 900°C and above the steels undergo breakaway oxidation.

From the post-breakaway rates measured for those two categories of steels at 900°C and above, it has been found that $\frac{1}{4}$Cr-1Mo steel has an activation energy for the oxidation reaction about twice as that of 9Cr-1 Mo steels. This larger activation energy has been attributed to the difference in the vacancy precipitation mechanism to form voids, which influences the rupture of the existing scales.

Acoustic emission technique has been used to detect the extent of spalling on the oxide layers formed on $\frac{1}{4}$Cr-1Mo steels. Initiation of breakaway oxidation in $\frac{1}{4}$Cr-1Mo steels has also been studied using this technique. These results confirm that the first step in the mechanism of breakaway oxidation for $\frac{1}{4}$Cr-1Mo steels is the mechanical cracking of the oxide scales.

The effect of prior cold work on both the steels has been found beneficial for oxidation resistance. Both short term experiments in oxygen and long term experiments in air show the decrease in oxidation rate as a result of cold work. In the case of $\frac{1}{4}$Cr-1Mo steel at 900°C, prior cold work prevented the initiation of breakaway oxidation, while for 9Cr-1Mo steel, a delay in the initiation of breakaway oxidation was observed. In protective range, the effect of prior cold work helps in
reducing the parabolic rate constant of the steels, while in the cases where breakaway oxidation has occurred, the post-breakaway linear rate decreased with increasing degree of prior cold work.

Most of the kinetics results have been correlated with the observations from the detailed analyses of the oxidized specimens using SEM, EDAX, EPMA, x-ray diffraction and AES/ESCA.

A mechanism is proposed to explain the inversion phenomenon in 9Cr-1 Mo steel. Higher rate of oxidation in steam has been explained in terms of existing theories. A mechanism for the enhanced oxidation resistance as a result of prior cold work has been proposed. The role of texture, arising as a result of cold-rolling, as one of the possible factors influencing the oxidation-resistance of these alloys, has been discussed.