additives used, phthalic acid, adipic acid, succinic acid and sodium thiosulphate (Krishnan 1984) reduced the chromium content in the effluent by forming complexes with the chromium. Auxiliaries made by the reaction of a polycarboxylic acid with a polyhydric alcohol, containing a variety of functional groups were used to produce soft leathers with better chrome uptake" (Träubel and Heinze 1980).

Tanning Trials in the presence of external chrome exhaust aids has been reported (Raghava Rao, 1991). The researcher used commercial exhaust aids Implenol A.P. (commercial product) Tuftan (commercial product) and ATC-21 (commercial product) respectively to study the effect of their role in chrome exhaustion. In a separate study (Singh et al 1988) Tuftan's role in chrome exhaustion has been reported. By application of this product only 5-10% of the offered chrome is let out in the effluent as against 25-35% in the conventional chrome tannage. Application of newly developed product during chrome tanning affords higher fixation of chromium oxide in leather, less untreated chrome sulphite in the effluent, with improved dye-ability of leather. Here one more advantage is seen that is imparting a filling effect without reduction in strength of the treated leathers. Subsequently the improved product Tuftan C was tested for its efficacy in chrome exhaustion with better results (Jayaraman et al 1989). In another process authors described the advantage of retanning with synthetic chrome agents. This process enabled high draining of chrome in retanning process, so that little chrome enters the wastewaters (Wehling et al 1988).

A new approach towards better exhaustion of chrome tanning has been described (Chandrasekaran 1987). Here in order to minimize the chrome in the effluent it was proposed to develop some auxiliaries which may have the ability to complex with the unfixed chrome and possess a reactive site to binding the protein substrate. A high exhaustion process has been developed using standard tanning materials which help to drastically reduce the chrome emissions in rechroming as well. Consequently, there is
no longer any need to do without rechroming for ecological reasons, as often used to be the case (Wehling et al 1988).

In another review the Author described high exhaustion process and recycling technology to make wet-blues (Higham, 1989). In another paper chrome containing polyacrylate complex was advantageously used for neutralizing chrome retannage. They have a high alkaline power and reduce the chrome in the residual float to the zone of about 10 mg/l (Schmidt 1989). A novel approach to increase the chrome exhaustion by designed structural changes in the sulphate salts has been reported (Raghava Rao et al 1992). A new cyclic tetra positive tetramer with low affinity to collagen contributing to nearly 50% of the chromium in the effluent has been identified in the spent chrome liquors (Raghava Rao et al 1992). Through designed alternations in the preparation of basic chromium sulphate tanning salts, significant reduction in the amounts of low affinity which ensures a chrome exhaustion of 85 ± 3% in the absence of an exhaust aid and 94-95% in the presence of external-aid has been developed. In another paper the main disadvantage from chrome salts utilisation in tanning process is described (Naviglio et al 1992). Here low chrome exhaustion is due to the high amounts of non-fixed chromium which remain in the tannery effluent and therefore in sludges. The research of processes able to improve the fixation and the irreversibility of chromium-collagen bindings with consequent floats of high exhaustion surely represents another step towards the optimization of the tanning cycle and the reduction of the environmental impact. A highly exhaustive chrome tanning process has been developed on the basis of the systematic studies of the isomerisation of maleic acid to fumeric acid (Francke 1992).

In another recent paper a description on a new non-polluting process using chromium salts and an investigation on the various factors are given. The new process considerably reduces the level of pollutants in the effluent and is suitable for larger scale operation. Complete exhaustion of
the tanning bath together with the traditional processes is carried out in aqueous media (Silverstre, 1994).

Very recently a low waste closed loop chrome tanning system based on Alutan-chrome combination and ethanol amine assisted method has been described (Chandrababu et al 1995).

We are reporting for the first time, the use of keratin hydrolysate (KH) as an exhaustion aid in the chrome tanning operations of leather processing (Ramamuthy et al 1989). The objective of introducing keratin hydrolysate in the chrome tanning and retanning operations of chrome tanned leather is three fold. Firstly, proteinaceous materials namely feathers and hairs which would otherwise go as waste is being converted into useful filling cum retanning material. Secondly this material can substitute the existing syntans and fillers which are costly, thus effecting economy of the leather processing. Thirdly since the chromium is fixed into the leather through keratin hydrolysate the chromium is reduced in the exhaust liquor thereby reducing the chrome pollution discharged into the effluent. In the present investigation keratin hydrolysate is used as an exhaustion aid for chromium salts. KH contains a variety of free groups such as carboxyl, amino, sulphoxide and others which help to improve chrome exhaustion of the bath.

3.2 MATERIALS AND METHODS
3.2.1 Materials

Poultry feathers were collected from TAPCO from the local unit of Tamil Nadu poultry development corporation, Chennai. Basic chromium sulphide used in this study was from our tannery in CLRI. Commercial BCS available in our tannery was used. Goat skins were procured from the local raw skin merchant. They were salted and kept for preservation in the cold room of CLRI tannery along with the stock of other hides and skins. Cow
hides were procured from the raw skin dealer. They were also preserved as mentioned above. The keratin hydrolysates was prepared by controlled alkaline hydrolysis as reported in Chapter 2.

3.2.2 Methods
Use of KH in the leather processing.
Conversion of 20 Goat skins upto pickle stage

Raw material (Goat skins)

20 wet salted goat skins were taken. Most of the skins had lengths in excess of 38 inches along the back bone.

Soaking

The skins were cut open. They were soaked overnight in 400% water, 0.1% preservative. Next day the skins were handled well and then drained. The skins were given two changes of water.

Liming (paint liming)

8% lime
2% sodium sulphide
20% water

The paint of the above composition was prepared and applied on the flesh side of the skins. The skins were paired flesh to flesh. Then they were piled overnight. Next day they were unhaired and relimed.
Reliming

200% water
5% lime
1% sodium sulphide

The skins were relimed in a pit. They were handled 3 times. Next day, after handling, they were removed and washed, scudded and washed.

Deliming

Deliming was done in a drum with 70% water, 1% Ammonium chloride. The drum was run for 40 minutes. The skins were checked for deliming and drained.

Bating

1% Bate-Lezyme A
70% water (37°)

Bating was done in a drum for 90 minutes. The skins were checked for bating and drained. They were dry drummed with 0.5% non-ionic wetting agent for 20 minutes.

This was followed by addition of 100% water and drumming for a further period of 20 minutes. The bath was drained and the skins were washed.

Pickling

60% water
6% salt
The drum was run for 10 minutes. Then 1% sulphuric acid dissolved in 10% water was added in 5 feeds at 15 minutes interval.

Then the drum was run for 30 minutes after the last feed. The skins were left overnight in the bath. Next day the drum was run for 20 minutes and checked for pickling and pH of the bath. The pH of the cut section was checked to be below 3.0. The pickle bath was drained.

3.3 USE OF KH IN THE LEATHER PROCESSING

20 goat skins were pickled as described above. The skins were cut in to halves and identified as 1L to 20 L (left sides) and 1R to 20R (right sides).

3.3.1 Use of KH in Chrome Tanning

12 left sides (1 to 12 L) and 12 right sides (9-20R) were first chrome tanned in three sets (1-4L, 9-12 R; Set 1, 5-8L, 13-16R; Set-2 and 9-12L, 17-20R; Set-3) in separate drums using a standard chrome tanning procedure with 8% basic chromium sulphate. Basification was carried out to pH 3.8 - 4.0 by adding sodium bicarbonate. After drumming for 3½ hours and checking penetration of the chrome, leather samples and exhaust liquor samples were taken. This was followed by the addition of KH to the level of 2%, 3% and 4% in the sets 1, 2 and 3 respectively. The offer of KH was based on the pelt weight. The drum was run for a further 40 min. and again the leather and the exhaust liquor were sampled. Similarly in set 4, 8 left sides (13-20L) and 8 right sides (1-8R) were chrome tanned together following the above procedure. After running the drum for 3½ hours leathers and exhaust liquor samples were taken and the drum was run for 40 minutes further with an addition of water only (Without KH). After 40 minutes leather and the exhaust liquor samples were again taken. This served as the control batch.
Both experimental and control lots were run under identical conditions using identical floats and equal running times in order to minimise experimental error.

3.3.2 Use of KH in Rechroming

The rechroming operation was divided into three sets using different drums for each set. In the first set 12 left (1-12L) sides (chrome tanned as described above) were rechromed with 5% basic chromium sulphate (2 hours) and the cross section pH was adjusted to 3.8 - 4.0 by using sodium bicarbonate. Leather and exhaust liquor samples were taken. KH was added to the same bath at the level of 2% (on the shaved weight of chrome tanned leather) and run for another 40 minutes. Again leather and exhaust liquor samples were taken.

In the second set, 12 right sides (9-20R) were first treated with KH to the level of 2% on the basis of shaved weight of the chrome tanned leather for 40 minutes and leather samples were taken. Basic chromium sulphate was added in the same liquor (5% of the shaved weight) and was run for 2 hours before the leathers were basified to pH 3.8-4.0. Leather and exhaust samples were taken.

In the third set of 8 left sides (13L-20L) and 8 right sides (1-8R) were rechromed with 5% basic chromium sulphate (2 hrs. 40 min) followed by basification as before. Leather and exhaust liquor samples were taken to serve as control batch.

All the three sets were run under identical conditions using the same volume of float and equal running times to minimise experimental error.
3.4 LEATHER TESTING

Chrome as $\text{Cr}_2\text{O}_3$ in both leather and exhaust liquors were estimated by the perchloric acid digestion method both in chrome tanning and rechroming. The method of estimation of $\text{Cr}_2\text{O}_3$ is described in Chapter II.

Physical test, parameters such as tensile strength, elongation at break, tongue tear resistance, double hole stitch tear strength, grain crack and burst strength were determined for each side of the leather. The leathers were all dried at ambient temperature (see Chapter II and Chapter IV).

Shrinkage temperatures were measured with a Theiss Shrinkage Meter calibrated to 0.1°C. Temperatures over 100°C were determined using glycerol as the immersion liquid.

3.5 LARGER SCALE TRIALS

The process was scaled up in our tannery using 10 cow hides. The cow hides were also soaked followed by other operations as mentioned below.

3.5.1 Conversion of 10 cow sides upto pickle stage

Soaking

The hides were soaked in enough water for 5 hours with two changes of water. The soaked weight was noted.
Liming

Liming was done for 18 hours in a pit as follows. 2.5% - sodium sulphide, 10% slaked lime was taken and enough water was added to make a paste. The sides were dipped in the above paste one by one and piled grain to grain. Next day, the sides were unhaired and relimed in a pit containing 300% water, 5% slaked lime. After 2 hours 0.5% soda ash was added. After 2 hours 2% salt was added and handled twice and left overnight. Next day, the limed pelts were washed, fleshed and scudded. The pelt weight was noted and then washed for 10 minutes with enough water.

Deliming

Pelts were delimed with 100% water, 1% ammonium chloride. Later the drum was run for 45 minutes and completion of deliming was checked with phenolphthalein. The goods were washed for 10 minutes.

Pickling

The pelts were pickled with 60% water, 8% salt. Run for 5 minutes. Later the pelts were run for 20 minutes in 10% water and 1% hydrochloric acid (in two feeds). Then 1% sulphuric acid, 10% water were added in two feeds at 10 minutes interval and run for 90 minute and the hides were left in the pickle liquor overnight. Next day, the pickled pelts were run for 30 minutes. The pH was found to be around 2.8 - 3.0. The hides were drained.

3.5.2 Usage of KH

The pickled hides were chrome tanned as follows. 2% KH was used in chrome tanning operation. Both of the chrome tanned lots (KH treated and control) were neutralised to pH 4.6-4.7 using a neutralising syntan (Vernatan AKM) and sodium formate.
The control leathers were then processed as follows: Prefatliquoring - 1% in 50% water. Retanning - 3% UF resin and 3% replacement syntan, (Basyntan DI) after 45 minutes 2% wattle extract was added. Dyeing was done in the same float with 0.5% dye, (acid black) 0.2% dye levelling agent (Tamol NNO) followed by the fatliquor - 0.5% formic acid and 1% cationic fatliquor (catalyx L).

The KH treated leather were processed in a similar manner except that the offer of the syntan was reduced to a total of 3% instead of 6% used previously.

The lots of leathers were piled overnight, hung to dry and staked after conditioning followed by dry drumming and toggling to complete the preparation to the crust stage. The crust leathers were assessed by a group of leather technologists.

3.6 RESULTS

Table 3.6.1 shows the chrome analysis of exhaust liquor and chrome tanned leathers. It is seen that it is possible to achieve more than 90% of exhaustion, of the chrome bath at 2% level of KH in the bath. Also the percentage of Cr₂O₃ in the leather increases by 0.5% when KH is employed as an additive in chrome tanning.

Table 3.6.2 shows the corresponding values for the rechromed leather. Here only 2% KH is used. In set 1 KH was added to the rechrome bath after the basification and in set 2, KH was added in the beginning and it was followed by addition of basic chrome salt.
Table 3.6.1

Analysis of Chrome tanned Leathers

<table>
<thead>
<tr>
<th>Sample</th>
<th>% of keratin hydrolysate added</th>
<th>% of exhaustion of chrome offered</th>
<th>% Cr(_2)O(_3) in leather</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before adding KH</td>
<td>After adding KH</td>
</tr>
<tr>
<td>Set 1</td>
<td>2</td>
<td>73</td>
<td>92.5</td>
</tr>
<tr>
<td>Set 2</td>
<td>3</td>
<td>75</td>
<td>91.5</td>
</tr>
<tr>
<td>Set 3</td>
<td>4</td>
<td>74</td>
<td>92.2</td>
</tr>
<tr>
<td>Set 4 (Control)</td>
<td>0</td>
<td>76</td>
<td>80.0</td>
</tr>
</tbody>
</table>

*Note: (Table 3.6.1) - 8% chrome salt was offered to the skins. Table refers to addition of KH in the exhaust chrome bath (see (i) in methods section)
Table 3.6.2

Analysis of Rechromed Leathers

<table>
<thead>
<tr>
<th>Sample</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of chrome in the leather</td>
<td>% exhaustion</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Set 1</td>
<td>4.76</td>
<td>0.18</td>
</tr>
<tr>
<td>Set 2</td>
<td>4.30</td>
<td>0.36</td>
</tr>
<tr>
<td>Set 3 (control)</td>
<td>3.62</td>
<td>0.28</td>
</tr>
</tbody>
</table>

* Note: (Table 3.6.2) mean and SD were calculated from 12 samples in sets 1 and 2 and 8 samples from set 3.

Set 1: 1-12L chrome tanned sides were rechromed with 5% basic chromium sulphate followed by the addition of KH (2%)

Set 2: 9-20R chrome tanned sides were first treated with KH (2%) and subsequently rechromed with 5% basic chromium sulphate.

Set 3: 13-20L, 1-8R chrome tanned sides were rechromed with 5% basic chromium sulphate alone (control set)
It is found here that chrome exhaustion is better in set 1, the percentage of chrome fixed is also high. On the basis of the result obtained it is suggested that KH should be added in the rechrome bath for better chrome exhaustion and increased chrome uptake by the leather.

Table 3.6.3 shows the shrinkage temperature of rechromed leathers of sets 1, 2 and 3. It is seen that the shrinkage temperature in set 2 is higher than for set 1 and 3 (control). Although the chrome exhaustion of the bath and chrome uptake by the leather is less in set 2, shrinkage temperature is high. This shows that the number of additional crosslinks involving keratin is greater in set 2. These crosslinks are stronger than those of chrome alone in set 1.

Data from physical parameters such as tensile strength (Table 3.6.4), Tongue tear resistance (Table 3.6.5), double hole stitch tear resistance (Table 3.6.6) and also grain crack (Table 3.6.7) and bursting strength (Table 3.6.8) showed that the use of KH has no deleterious effect on the leathers and does in fact tend to improve certain physical properties, i.e., set 1 compared to set 2 and set 3.

Assessment of crust leathers (cow hides) was made by experienced leather technologists and is given in table (3.6.9). These visual assessments showed that the use of KH which helped in giving better chrome exhaustion and improved chrome uptake also permits the reduction of syntan by 3%. Therefore the overall cost involved in using KH for chrome exhaustion is nullified by the reduced offer of the syntan and retanning materials.
### Table 3.6.3

**Shrinkage Temperature**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Shrinkage temperature</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set 1 KH added in rechrome bath</td>
<td></td>
<td>121.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Set 2 KH added before rechrome</td>
<td></td>
<td>124.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Set 3 (control)</td>
<td></td>
<td>119.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Shrinkage temperature was measured using a theiss shrinkage meter, measuring to 0.1°C. Glycerol was added as a medium for measuring shrinkage temperatures above 100°C.

**Note**: Sample identification is as for Table 3.6.2
Table 3.6.4

Tensile Strength (kg/Cm²)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tensile Strength Kg/Cm²</th>
<th>Elongation at break %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Set 1 KH added in rechrome bath</td>
<td>185</td>
<td>12.2</td>
</tr>
<tr>
<td>Set 2 KH added before rechrome</td>
<td>181</td>
<td>8.4</td>
</tr>
<tr>
<td>Set 3 Control</td>
<td>180</td>
<td>19.7</td>
</tr>
</tbody>
</table>

Same identification is as Table - 3.6.2
Table 3.6.5

Tongue Tear Resistance kg/cm

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tongue tear resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Set 1 KH added in rechrome bath</td>
<td>15.2</td>
</tr>
<tr>
<td>Set 2 KH added before rechrome</td>
<td>12.4</td>
</tr>
<tr>
<td>Set 3 Control</td>
<td>11.6</td>
</tr>
</tbody>
</table>

Sample identification as Table 3.6.2
### Table 3.6.6

**Double Hole Stitch Tear Strength**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Stitch Tear strength (Double Hole) kg/cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Set 1 KH added in rechrome bath</td>
<td>76.2</td>
</tr>
<tr>
<td>Set 2 KH added before rechrome</td>
<td>67.5</td>
</tr>
<tr>
<td>Set 3 Control</td>
<td>66.8</td>
</tr>
</tbody>
</table>

Sample identification as Table 3.6.2.
Table 3.6.7
Grain Crack Strength (kg/cm)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Grain crack strength</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Set 1 KH added in rechrome bath</td>
<td>224.7</td>
</tr>
<tr>
<td>Set 2 KH added before rechrome</td>
<td>190.6</td>
</tr>
<tr>
<td>Set 3 Control</td>
<td>187.4</td>
</tr>
</tbody>
</table>

Sample identification as Table 3.6.2.
Table 3.6.8
Bursting Strength (kg/cm)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Bursting Strength</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Set 1 KH added in rechrome bath</td>
<td>370.4</td>
<td>33.5</td>
</tr>
<tr>
<td>Set 2 KH added before rechrome</td>
<td>353.8</td>
<td>29.7</td>
</tr>
<tr>
<td>Set 3 Control</td>
<td>348.0</td>
<td>18.6</td>
</tr>
</tbody>
</table>

Sample identification as Table 3.6.2.
Table 3.6.9
Assessment of crust leather

<table>
<thead>
<tr>
<th>Property</th>
<th>Crust stage assessment of cow upper leather</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental</td>
<td>Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean*</td>
<td>SD*</td>
<td>Mean*</td>
</tr>
<tr>
<td>Appearance</td>
<td>7.2</td>
<td>1.1</td>
<td>7.1</td>
</tr>
<tr>
<td>Surface smoothness</td>
<td>6.4</td>
<td>0.6</td>
<td>6.5</td>
</tr>
<tr>
<td>Colour</td>
<td>6.6</td>
<td>0.9</td>
<td>6.2</td>
</tr>
<tr>
<td>Fullness</td>
<td>7.8</td>
<td>1.2</td>
<td>7.2</td>
</tr>
<tr>
<td>Feel</td>
<td>7.1</td>
<td>0.4</td>
<td>6.9</td>
</tr>
<tr>
<td>Strength</td>
<td>6.8</td>
<td>0.4</td>
<td>6.2</td>
</tr>
</tbody>
</table>

* Mean and standard deviation were calculated from five assessments.
3.7 DISCUSSION

In the present investigation keratin hydrolysate has been effectively used as an additive in chrome tanning and rechroming operations to give better exhaustion of the chrome bath. KH was prepared from tannery hair or poultry feathers. Both sources are rich in keratin proteins. Conversion of both, tannery hair (obtained from the limeyard) and poultry feathers into hydrolysates would eliminate the environmental pollution posed by these materials. Poultry feathers are a waste material in India and do constitute an environmental hazard. The situation with tannery hair is also similar. Tannery hair is burnt off in liming operations using lime and sodium sulphide. The disposal of the burnt hair along with lime and sulphide is a major problem to a tanner. Conversion of these materials into KH would reduce pollution at two levels in a tannery. Firstly, utilisation of pollution causing burnt off hair and secondly removal of chromium salts from the waste liquors. It helps in reduction of consumption of basic chromium sulfate in the tanning process. The tanneries consuming large quantities of BCS can effectively save on this chemical, if they use KH in leather processing.

Considering the mechanism of action of KH, we know that tanning action is brought about on the side chains of aspartic and glutamic acids of collagen. These are the \( \beta \) and \( \gamma \) carboxyl groups of collagen which are localised in clusters. In most cases side chains are always found to occur in the immediate neighbourhood of the carboxyl group.

They are so situated that reaction can easily take place in the form of cross-bridges between these groups and complexes.

The addition of trivalent chromium to the negatively charged S groups and carboxyl groups of glutamic and aspartic acids which are liberated during the hydrolysis of keratin at high pH may also occur in a
similar way as the carboxyl groups of glutamic and aspartic acids present in collagen react with chromium (Beikiewiz 1983).

The Fig. 3.7.1 shows the ionic form of BCS in solution and then in masking. It is observed that in a series of experiments using KH as a chrome exhaustion aid in leather processing, the fixation of keratin into the leather is always routed through chromium. It is not possible to directly link the KH to collagen. Once the chromium is fixed to the leather then KH can be easily complexed (Fig. 3.7.2 and Fig. 3.7.3). Once the KH is complexed to Cr-tanned leather, it offers additional carboxyl groups to the leather matrix. This additional carboxyl groups help in further fixation of chrome to already chrome tanned leather. Higher fixation of chrome to leather ultimately gives higher exhaustion of the chrome bath. In experimental batch test scale level at around 93% exhaustion of chrome bath was achieved. In commercial chrome tanning operation we expect around 85% exhaustion of the chrome bath with KH. This additional fixation of chrome is due to complexing of KH to Cr-tanned leather Fixation of KH to leather can be achieve in two ways. In the first case, (Fig. 3.7.2) Kh is added to chrome tanned leather, the presence of KH in leather subsequently helps to improve the chrome exhaustion of the rechrome bath.

In the second case (Fig. 2.7.3) the chrome tanned leather is first rechromed, this is then followed by addition of KH in the rechrome bath after exhaustion. KH will complex with Cr (in the exhaust) and this Cr-KH complex will be taken up by the chrome tanned leather since it has affinity for KH.

Fig. 3.7.3 shows the fixation of more chrome, in rechroming operation in the presence of KH.
IN SOLUTION

\[
\text{CrOH SO}_4
\]

(Cr is +3) --------------------------- ►

BASIC CHROMIUM SULPHATE

\[
\begin{align*}
&\text{Cr}^+ \quad \text{OH} \\
&\text{SO}_4 \\
&\text{Cr}^+ \quad \text{OH} \\
&\text{SO}_4
\end{align*}
\]

IN MASKING

\[
\begin{align*}
&\text{OH} \\
&\text{SO}_4 + \text{SODIUM FORMATE} \\
&\text{FORMATE} \quad \text{OH} \\
&\text{FORMATE} \quad \text{OH}
\end{align*}
\]

Fig.3.7.1  Ionization of BCS in solution and in masking
Fig. 3.7.2 Fixation of keratin to Cr-tanned leather and complexing of keratin-Cr-tanned leather with chromium
Cr TANNED LEATHER

FULLY CHROME TANNED LEATHER

STEP.1

Cr TANNED LEATHER

FULLY CHROME TANNED LEATHER

+ RECHROMING SOLUTION

KH-COMPLEXED FULLY Cr TANNED LEATHER

KH-COMPLEXED FULLY Cr TANNED LEATHER

(KH-Cr)

STEP.2

+ KH SOLUTION
+ EXHAUST LIQ.

Fig.3.7.3 Fixation of keratin to fully Cr-tanned leather
From the above discussion, it is seen that keratin can act as a bridge between two chromium moieties. Chrome salts removed from the exhaust liquor are fixed into leather thereby increasing the Cr content of the leather as is shown in the results. There is possibility of cutting the consumption of basic chromium sulphate when KH is used in leather processing during chrome tanning and rechroming operation. This will ultimately help the tanners to economize their leather processing and also reducing chromium discharge to the effluent.