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Optimization of the inner surface zinc layer thickness in the steel pipe galvanizing

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Abstract: The zinc coating of steel pipes is mainly a function of base metal chemistry, surface condition, aluminum addition to the bath, dipping time, zinc bath temperature, withdrawal angle and speed, outside wiping pressure, inside blowing media, time and pressure. Especially for pipe galvanizing, withdrawal speed plays a very important role to optimize inner surface zinc coating thickness. Therefore, influences of withdrawal speed and also inside blowing pressure on inside zinc coating thickness of the steel pipe were investigated by some practical experiments.

Introduction

Hot dip galvanized zinc coatings are applied to steel pipes to provide protection against corrosion. To achieve satisfactory galvanizing, pipes must have a clean metallic surface. Therefore, the pipes are subjected to chemical treatment and then dried in a continues drying chamber. After surface preparation and drying, the pipes are dipped directly into the galvanizing kettle, which contains molten zinc at temperatures usually in the range of 445 to 465 ^oC. In the kettle, firstly the material reaches the temperature of the molten zinc and then zinc layer on the surface of the pipe is formed by diffusion reaction.

After a certain time, usually called as dipping time, pipes are extracted from the zinc bath at a given withdrawal speed. At this stage, outside wiping is done to reduce outer coating thickness. At the same time, zinc drainage from the inside surface of the pipe happens because of extraction angle. Just after completion of extraction, the pipes are subjected to steam blowing to clean inside surface of the pipes. Finally, the pipes are cooled in a water bath at a temperature of 60–90^oC to end diffusion reaction due to retained heat.

In addition to the composition of base metal, surface condition of pipes after chemical treatment and aluminum addition to the bath, the zinc coating is mainly a function of dipping time, molten zinc temperature, withdrawal angle and speed, outside wiping pressure, inside blowing media, time and pressure.
It is possible to obtain outside coating thickness in the range of 300 grs/m^2 with a well designed air wiping die. However, the main subject of the steel pipe galvanizer' s is to keep the inside coating thickness in a minimum level which already should match the requirement of the standards. Optimization of the inner surface zinc layer thickness in the steel pipe galvanizing mainly related to withdrawal speed and inside blowing pressure. A study of the influence of withdrawal speed and inside blowing pressure on inside coating thickness was carried out by means of various practical experiments.

Experimental Procedure

The experiments were carried out using the following steps;

1. At first, the pipes are subjected to chemical treatment. The condition of chemical treatment is given below;

degreasing : 5% conc. alkaline cleaning
pickling : 15% conc. H_2SO_4 with max. 50 gr/l Fe.
fluxing : 30 ^{o}Be

2. Experiments were carried out by varying withdrawal speed and inside blowing pressure while keeping the rest at constant values as given below;

bath temperature : 450 – 455 ^oC
outside wiping pressure : 1 bar
withdrawal angle : 15^o
inside blowing media : overheated steam-350 ^oC
inside blowing time : 1,5 sec.

3. It is taken 10 cm long samples out of each meter of pipe length. From each pipe, 7 samples are taken and numbered 0 to 6. Number 6 represents the front edge of the pipe which exit out of zinc bath firstly and in the same manner number 0 represents the rear edge (see Fig 1).

4. For each sample, inside coating thickness in gr/m^2 is measured by chemical way. The results obtained are given in Tables 1 to 8.

Result and Discussion

Table 1 and 2 give the obtained coating thickness in grs/m^2 for ½" pipes. It is noted that, the average thickness is 1510 grs/m^2 for 1,2 m/sec. withdrawal speed and 1428 grs/m^2 for 1,0 m/sec. withdrawal speed. There is around 5,5% decrease in the amount of zinc carry over in grs/m^2 inside surface area. All the other diameters also show same tendency. For instance, 2" diameter pipes (Table 7 and 8), average coating thickness is 1083 grs/m^2 for 0,86 m/sec withdrawal speed, while it is 973 grs/m^2 for 0,5 m/sec.

Table 5 gives the average coating thickness for 11/2" pipe with 0,86 m/sec. withdrawal speed. The quantity of zinc carry over on pipe is around 1042 grs/m^2 while the remaining quantity is 454 grs/m^2 after inside blowing. On the other hand, when the withdrawal speed is decreased to 0,5 m/sec (Table 6), the percentage of remaining quantity will be 55% while it was around 44% before. When the blowing pressure is increased, the coating thickness is decreased relatively (Table 3 and 4).

Conclusion

a) It is obviously that zinc outlet, coming from the inside surface of the pipes during the extraction, is directly related to withdrawal speed. The slower withdrawal speed cause to having less zinc carry over on the pipe surface because of longer extraction time.

b) There is always a big risk to stay under the 400 gr/m^2 as coating thickness after blowing if the zinc layer temperature is still too high results from short extraction time. It is noted that, slower withdrawal speed allows longer time to zinc layer to solidify. That will help to the galvanizers to perform standard requirements for inner coating thickness with the minimum usage of zinc. On the other hand, too long extraction time causes to solidify zinc layer before coming to inside blowing station. This results in poor dust collection and also unacceptable rough surface.

c) The lower withdrawal speed result in thinner zinc coating. On the other hand, too slow extraction causes both unacceptable surface and low production speed. Therefore, it is suggested that, each mill should make their own trials to establish a good balance between zinc usage and production speed by defining withdrawal speed and inside blowing pressure acc. to diameter of the pipe.

References

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Author biography

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Figures and Tables

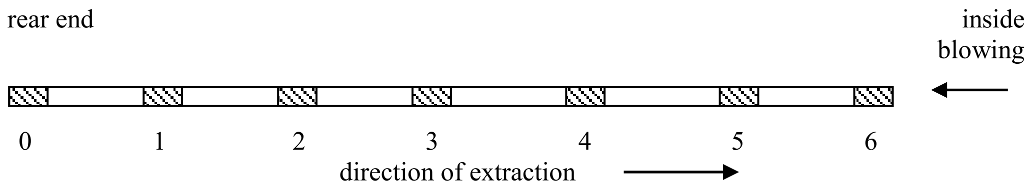

Figure 1. Positioning of samples along the pipe.

Table 1. ½” pipe inside coating thickness (grs/m^2). Withdrawal speed : 1,2 m/sec

0	1	2	3	4	5	6	average	blowing pressure
886	1132	1344	1511	1710	1870	2115	**1510**	-
638	803	756	696	670	686	599	**693**	7 bar
613	624	641	684	623	583	492	**609**	9 bar

Table 2. ½” pipe inside coating thickness (grs/m^2). Withdrawal speed : 1,0 m/sec

0	1	2	3	4	5	6	average	blowing pressure
870	1150	1350	1521	1571	1711	1824	**1428**	-
707	715	739	769	739	732	684	**726**	7 bar
587	652	687	747	696	690	636	**671**	9 bar

Table 3. 3/4” pipe inside coating thickness (grs/m^2). Withdrawal speed : 1,2 m/sec

0	1	2	3	4	5	6	average	blowing pressure
656	925	1132	1220	1340	1522	1636	**1204**	-
571	611	648	656	602	508	465	**580**	6 bars
538	632	557	612	562	479	431	**544**	8 bars
544	640	552	543	424	373	325	**486**	10 bars

Table 4. 3/4” pipe inside coating thickness (grs/m^2). Withdrawal speed : 0,86 m/sec

0	1	2	3	4	5	6	average	blowing pressure
615	834	996	1120	1218	1376	1408	**1081**	-
570	676	599	671	697	592	498	**615**	6 bars
529	646	558	573	609	507	437	**551**	8 bars
540	622	593	510	549	453	356	**518**	10 bars

Table 5. 11/2” pipe inside coating thickness (grs/m^2). Withdrawal speed : 0,86 m/sec

0	**1**	**2**	**3**	**4**	**5**	**6**	**average**	**blowing pressure**
690	854	965	1142	1190	1228	1227	**1042**	-
487	536	630	535	353	342	295	**454**	10 bars

Table 6. 11/2” pipe inside coating thickness (grs/m^2). Withdrawal speed : 0,60 m/sec

0	**1**	**2**	**3**	**4**	**5**	**6**	**average**	**blowing pressure**
607	740	852	941	1008	1048	1144	**906**	-
507	560	581	568	506	400	343	**495**	10 bars

Table 7. 2” pipe inside coating thickness (grs/m^2). Withdrawal speed : 0,86 m/sec

0	**1**	**2**	**3**	**4**	**5**	**6**	**average**	**blowing pressure**
753	883	1015	1132	1189	1241	1369	**1083**	-
514	581	597	586	524	451	384	**520**	10 bars

Table 8. 2” pipe inside coating thickness (grs/m^2). Withdrawal speed : 0,50 m/sec

0	**1**	**2**	**3**	**4**	**5**	**6**	**average**	**blowing pressure**
707	810	911	1008	1104	1061	1211	**973**	-
659	740	765	797	708	606	456	**676**	10 bars