Operational Experiences and Practices of Mild Steel MG Cylinder

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ABSTRACT

In India, many mills are producing quality poster paper, some using MS MG cylinders in place of conventional CI MG cylinder. Their product quality is equivalent to those using CI MG cylinder, or even better in some cases. The object of this work is to show how an MS MG cylinder can be used for the production of quality poster paper, and how the different problems faced during the operation of the same can be sorted out.

Introduction

Conventionally, CI MG cylinders were considered a must for production of MG poster paper. But a close analysis of properties of mild steel and gray cast iron indicates the possibility of using mild steel cylinders for this purpose. The following points justify the same-

1. Microscopically, the mild steel surface is much smoother than the paper surface, and hence use of mild steel cylinder should not create any problem. Cast iron surface is relatively smoother than that of mild steel, but its smoothness increase does not yield significantly in gloss while producing quality paper. Furthermore, with advancement of metallurgy, the microstructure of mild steel has improved a lot.

2. The specific heat of gray cast iron (0.130 Kcal/Kg^{0}C) is higher than mild steel (0.114 Kcal/Kg^{0}C) that is why, it takes longer times to heat up and cool down the cylinder. Quick speed & hence draw changes, and control of moisture in mild steel cylinder is obviously much better than in case of cast iron cylinders. Furthermore, as the strength of mild steel is higher, specially in the grades like IS:515 (eq. A36, ASTM), we require less shall thickness, hence the heat capacity of cylinder is low. Furthermore, the heat transfer coefficient is better.

3. Thermal conductivity of mild steel (40 Kcal/m.Hr.^{0}C) is around 15% lower than that of cast iron(48 Kcal/m.Hr.^{0}C), but its impact on overall heat transfer coefficient will be to the tune of 5-6% only, as other resistances to heat flow e.g. condensate layer, paper web etc. do add to the overall system resistance, thereby production rate reduction will be less. Furthermore, by using steam of slightly higher pressure, this loss of production can be compensated.

4. Relatively softer nature of mild steel makes it possible to grind MG cylinder within 3-4 days, against 7-10 days required for CI MG cylinder.

5. Mild steel being a soft material unlike CI which is brittle, the accidental risk of MG cylinder is minimized to a significant level.

6. Manufacturing of a cast iron cylinder takes nearly 4-6 months, against 45-60 days required for fabrication of a mild steel MG cylinder.

7. Improper casting of a MG cylinder means a rejection of material and time involved, while raw material including MS plates, welding rods, shaft/journal etc., welding rods used etc. can be tested prior to fabrication to ensure the product of high quality.

8. Relatively higher wear and tear rates of mild steel are not of so much significance as an ordinary mild steel MG cylinder can easily give a life of ten years and more, after which it can be replaced, within a week.

9. Finally, an MS MG cylinder can be made available in less than one fourth of the cost of a CI MG cylinder.

MG Poster paper is now being made on Indian Machines using Mild Steel MG Cylinder. Having a close look on the paper produced by such machine will reveal that the paper is of even better glaze than the conventional CI MG cylinders.

Quality Control & Assurance for Mild Steel MG Cylinders:

It is important to know how product quality can be maintained during manufacturing of an engineering product of significant interest. Papermakers usually take nip impressions during change of touch roll, to ensure that the nip is uniform and hence paper quality would be acceptable at each cross direction position of the machine. Some papermakers even consider the nip impression as important as cardiograph of a heart patient.

The property variation in CI MG cylinders is easily possible. For casting of steel, uniform product mixes is prepared, melt, and poured in moulds. As a significant quantity of metal is required, the pouring takes a lot of time, and hence there remain chances of temperature and hence material properties variation at different locations. On the other hand, the plates used for fabrication of MG cylinder are made by big rolling mills that make only mild steel plates, and thus are able to produce material of uniform quality. Furthermore, plates received by the manufacturer can be tested for composition as well as for chemical and mechanical properties. With mild steel ultrasonic testing can be easily done to determine whether the plate is free from defects e.g. inside air bubble etc. Ultrasonic testing is not possible with CI MG cylinders.

After SR, if required, MG can be spray coated with a metal of higher hardness, to improve its wear resistance, and longer service duration between two grindings. Well-equipped workshops, and well-qualified and experienced operators are the key of excellence in MG manufacturing.

Operational Experiences:

Quick Startups:

After a long shut, for example the annual maintenance shut or annual shut for boiler inspection, it has been

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observed that the machine can be started within a short span of time. Typical time to reel the paper after the steam is available is kept 4-6 hours for CI cylinders. With mild steel MG cylinder, it has been reduced to only 90-105 minutes. This results in 3-4 hours more available time every year for production.

Delicate Surface:

Mild steel being a softer one, one has to take extra precautions for ensuring that its surface remains clean and uniform during operation. Use of softer doctor blades such as phosphor bronze or epoxy blades (like Hylam) is advisable. But, it is more important to maintain a correct doctor blade angle and periodic inspection of blade condition.

Splash of water directly on MG surface is extremely harmful. Sudden temperature variation that too in a localized area often results in development in surface irregularities. So, if due to any reason, the temperature of MG surface has increased beyond desired limits, the best way is to reduce steam pressure by releasing some of the steam, closing steam valve temporarily, and wait. Usually, the temperature is controlled within 4-5 minutes.

In some instances, it has been observed that due to some foreign material, a scratch line developed all over the circumference of MG cylinder. MG operators need to be extra careful for the same, and if such a line (groove) has developed, use of emery strip throughout the deckle on the doctor blade can be made for a couple of hours so that the problem is solved. It must be noted that the emery must be a finer one and the strip is replaced every 10-15 minutes. Use of 150# emery followed by 180# and skotch brite has been found useful for the same. A careful and attentive operator can easily increase mean time between grinding to up to two years or more.

Doctor Blade Setting:

Setting up a new doctor blade is another crucial activity. We all know that the doctor blade must be straight, impart uniform pressure on MG throughout the deckle. Also, the angle of doctor must be proper. But, often the papermakers can be seen complaining about improperly fit doctor blade, indicating that a piece of paper can be inserted at this or that location at MG doctor.

In fact, if the doctor holder is correct, doctor blade is straight, and is of good quality, this problem should never appear. If it appears, there could be only two possible reasons. Firstly, the groove in the doctor blade holder is plugged with fibers and fines dust. For the same, every time the doctor blade is replaced, the groove must be cleaned with compressed air jet. Secondly, there might be a possibility of uneven surface.

Surface unevenness, once developed, is very hard to even out. If surface is more worn out at a particular position, to avoid the gap between doctor blade and MG surface, a localized increase in blade pressure becomes necessary. In most of the cases, the applied pressure is more than that really required and hence, further deterioration of MG starts. As a result, the problem increases further.

Monitoring of MG Surface:

As obvious, regular monitoring of MG surface is extremely important. But, it is not easy to put a straight edge and dial gauge or some sophisticated equipment for the same. There are several simple ways for regular monitoring of the MG surface without affecting the production. The first involves looking the reflection of a tubelight installed at one side of MG from the other end. A wavy reflection indicates uneven surface.

The other method is analysis of CD profiles. In this technique, the averaged profile for a number of days at different locations is studied. When the averaging is done for a fairly long duration e.g. for a week or for 15 days, the effect of headbox pulsations, approach flow pulsations, and similar non-uniformities is damped. Once the averaged profile is obtained, absolute profile is computed by subtracting profile average value from the individual values. Ideally, one should get a perfect zero-zero- profile. A reduced basis weight at a particular position hints worn out MG at that particular position.

This method, when used properly, hints about the problematic zone in MG. If precautions are made the problem does not increase, and sometimes, the problem is reduced significantly. This can be seen in the following case study.

Case Study:

Here, the case of a MG machine is being discussed. The machin is a typical fourdrinier machine, with solid couch, single press roll, single touch roll (solid), and a fabricated MG. The MG is made of ASTM A36 grade carbon steel. The chemical composition of plates used to fabricate this MG is as under-

Element	Composition
Carbon	0.14-0.15%
Manganese	0.95-0.98%
Silica	0.31-0.27%
Phosphorus	0.029-0.031%
Sulphur	0.015-0.017%
Nickel	0.03-0.04%
Chromium	0.02-0.03%
Molybdenum	0.007%

This chemical composition, however, also confirms to IS:2002 (Steel plates for pressure vessels for immediate & high temperature service including boilers) and IS:2062 (Steel for general structural purpose).

Duration	Position												Var.	Avg.
	1	2	3	4	5	6	7	8	9	10	11	12		
JAN_1-15	45.3	45.5	45.5	45.5	45.2	45.2	45.4	45.3	45.2	45.5	45.4	45.3	**0.3**	**45.4**
JAN_16-31	43.0	43.3	43.0	43.2	43.2	43.2	43.2	43.2	43.2	43.3	43.3	43.0	**0.3**	**43.2**
FEB_1-15	42.0	43.0	43.0	43.1	42.8	43.1	43.2	42.1	42.8	42.9	42.8	42.7	**1.2**	**42.8**
FEB_16-28	41.2	41.9	41.8	41.8	42.0	41.6	42.0	41.8	41.8	41.5	41.8	41.7	**0.8**	**41.7**
MAR_1-15	49.0	50.0	50.1	50.2	50.0	50.1	49.9	50.2	50.0	49.9	50.1	49.8	**1.2**	**49.9**
MAR_16-31	45.8	46.6	46.3	46.5	46.4	46.5	46.7	46.6	46.7	46.4	46.5	46.3	**0.9**	**46.4**
APR_1-15	50.5	51.0	50.9	51.0	51.0	50.9	51.0	51.1	50.9	50.8	50.7	50.6	**0.6**	**50.9**

Table 1: Averaged profile

Duration	Position											
	1	2	3	4	5	6	7	8	9	10	11	12
JAN_1-15	-0.1	0.1	0.1	0.1	-0.2	-0.2	0.0	-0.1	-0.2	0.1	0.0	-0.1
JAN_16-31	-0.2	0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	-0.2
FEB_1-15	**-0.8**	0.2	0.2	0.3	0.0	0.3	0.4	-0.7	0.0	0.1	0.0	-0.1
FEB_16-28	**-0.5**	0.2	0.1	0.1	0.3	-0.1	0.3	0.1	0.1	-0.2	0.1	0.0
MAR_1-15	**-0.9**	0.1	0.2	0.3	0.1	0.2	0.0	0.3	0.1	0.0	0.2	-0.1
MAR_16-31	**-0.6**	0.2	-0.1	0.1	0.0	0.1	0.3	0.2	0.3	0.0	0.1	-0.1
APR_1-15	**-0.4**	0.1	0.0	0.1	0.1	0.0	0.1	0.2	0.0	-0.1	-0.2	-0.3

Table 2: Absolute profile (average of profile subtracted from individual values)

To begin with, the averaged profile at different location was started to record. Fortnightly average values are given in table 1.
As we can see that the profiles in the month of January are fairly good. But, to get more meaningful information, the absolute profiles are computed by subtracting the respective average value from the individual values. By this we get a data like given in table 2.

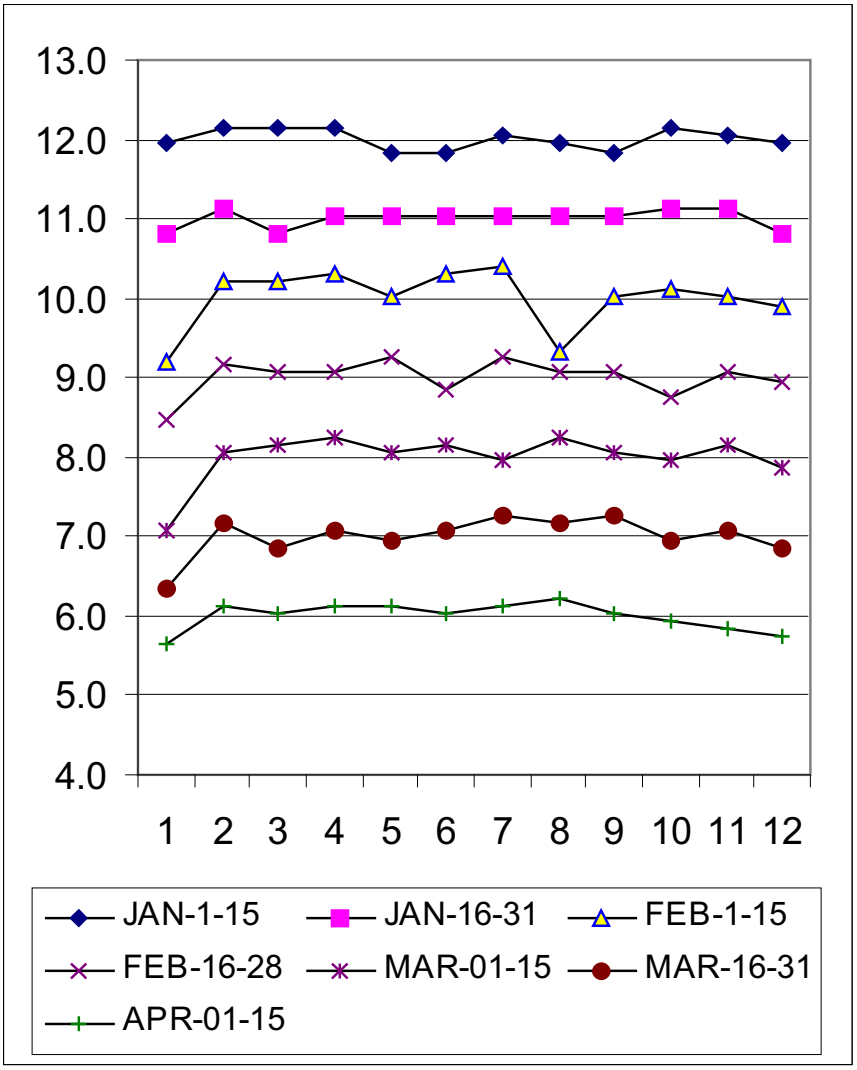
Here, we can see that in the month of January, the profiles were satisfactory. A graph is shown in figure 1 with the above data to illustrate the graphical representation of changes in absolute profiles.

But, in the first fortnight of February, at position 1 and 8, the values were much less. This indicated the problem at position 1and position 8, and process personnel were advised to keep a close watch on the same. Soon, the problem at position 8 was significantly improved. All that was done was to run the machine with applying a lower doctor pressure locally at these positions. But, the problem at position 1 could not improve easily. This was due to the fact that after every break, during tail feeding, there was a problem of paper jamming in the doctor blade.

To solve the problem, the doctor blade loading was just slightly reduced at position 1. As a result, there is a slow but consistent reduction in the problem at position 1.

Conclusion:

The above discussion indicates that it is even better to have a new machine installed with fabricated mild steel MG cylinder in place of a CI one. On machines with old CI cylinders, next replacement can be done with a fabricated MG cylinder. Since mild steel properties are different from cast iron, it is desired to change the operational practices accordingly. With the use of surrogate techniques like visualizing reflection of MG surface or by checking paper profiles, the condition of MG can be accessed on regular basis.



Suggested Reading:

1. Singhal, D.K., "Mild Steel MG Cylinders", 2005, http://www.paperonweb.com/articles/MILD_STEEL_MG_CYLINDER.ppt
2. Singhal, D.K., "A Discussion on Yankee Safety Issues", 2007, http://www.paperonweb.com/Articles/Yankee_Safety_by_DKSinghal.ppt