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SAFE STORAGE OF PAPER & WASTE PAPER AND ITS HANDLING FOR ACCIDENT FREE OPERATION

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Abstract:

For past few years, end of winter months have been really tough for paper mills. These months often witness maximum fire accidents particularly in paper mills. This year too, some severe fire incidents were reported. Fortunately no casualties were reported in such incidents, but the quantum of losses was huge. This paper explores some possible strategies which may be considered to reduce the possibility of fire mishaps significantly.

Keywords: Paper Mill, Fire, Safety, Hazard, Accident, Waste Paper.

Introduction

A friendly question with one of my friends turned into a serious discussion. The question was- "What strategies/arrangements do you have to avoid fire accidents?" The obvious answer included the number of fire hydrants, hose reels, branch pipes, fire extinguishers, automatic fire alarm, sprinklers etc. But, the counter question was- "Most of these shall be used only after a fire breaks out. But, how do you ensure it does not initiate at first instance?"

Since then, I've continuously been struggling to think, "WHY" on this issue. Why do such incidents take place? Quite obviously, one may easily blame mills for not following the best practices; one may blame the mills for not taking the fire safety seriously; one may blame the mills for being careless and this and that.

Is it really the case? Can any mill, can any management, can the staff and workers be so careless about their mill that their future and lives are on risk? Sorry. I don't think so.

Please allow me to put all such information combined together, to see if we can get some suitable solution.

The Approach We Follow

The general approach being followed towards fire safety, so far, is confined towards these major targets-

- Handling and storing the flammable material safely,
- Keeping all fire-fighting equipment operative,
- Train workforce about use of fire hydrants, extinguishers etc.

Be it fuel, petrol or paper, cloth or chemical, furniture or livestock, the basic approach remain the same. Most of our focus is to how quickly and efficiently we can stop fire once it has initiated. On the other hand, how to stop the initiation of fire itself, there are just a few guidelines-

- Avoid having electrical connections or wires in fire prone area.
- Ban use of cigarettes, bidi and matchbox, lighter etc. in fire prone areas.

Not only this, there are detailed recommendations on size and layout of storage yards, godowns but still, these are mainly for fire-fighting purpose only. The change in climatic conditions or change in properties of material stored to reduce fire propagation is usually out of field of fire-fighting experts. Let us have a look at fire hazard timeline-

Image 1: The Fire Timeline

As clear from the image, we need to pay maximum attention to avoid the initiation of fire. For the same, improved focus on the first two sections of the image is a must, while, our main focus often revolves around the third and fourth. In fact, the first point itself- "No Fire: No action is needed" needs a serious review. Let us explore mainly with reference to paper.

Understanding Paper with Reference to Fire Hazard

Every time, I read or hear news about a fire accident particularly in a paper mill, I wonder why adequate research has not been done to avoid such fire accidents for paper mills. Of course, today we know a lot about paper, its composition, physical and chemical properties and even the microstructure etc. But, do we have enough published information about fire-catching properties of paper?

The Physical Nature of Paper/Waste Paper

For any flammable material, the critical parameters usually described are- calorific value, oxygen requirement for combustion, adiabatic flame temperature (in fact the function of first two), ignition temperature etc. But, is that really enough? Please do have a look at the following images-

Can you tell which can catch fire easily? In fact, compared to typical figure of 10-20m2/ton for a solid reel (image 4), the paper cuttings/

Image 2 and 3: Wood (Solid & Scrapings) *(Image courtesy: Google)*

Image 4 and 5: Paper (In reel and cuttings) *(Image courtesy: Google)*

trimmings (image 5), have specific surface area of 40,000-50,000 m2/ton. Definitely, this results in easier spreading of fire. This also highlights the fact that the physical nature of the material is extremely important to consider while planning about fire safety.

Hygroscopic Properties of Paper

A step further, paper has another interesting property. It absorbs moisture from atmosphere when the relative humidity is high, and releases moisture when the atmospheric humidity is low. So, the weight of paper increases if it is kept in high humidity; and decreases if it is kept in dry atmosphere. Well, the process is relative slow for some grades, but this also plays an important role on many other processes. Moist paper, when comes in contact with dry air, starts losing of its moisture and hence, its temperature falls slightly. Moist paper is slightly conductive while the dry paper acts as an insulator. It has been found that ambient relative humidity below 35% RH can adversely affect paper and decrease its conductivity, which results in greater potential for static charge and spark.

The Calorific Value

The reported calorific value of paper is around 3000 kCal/kg. Can we do something to reduce it down? Will it make any significant impact?

When paper is kept at low humidity level for longer duration, its moisture content decreases, and it becomes easier for paper to catch fire. That is why, in humid summer, there are relatively less chances of such accidents. Paper is a little hydrophilic. If paper is kept at say 10% moisture, the calorific value decreases from 3000 kCal/kg to say 2640 kCal/kg (the moisture also needs some energy to get evaporated). Furthermore, spraying water would also drop down temperature slightly. However, this change in calorific value (3000 to 2640) does not seem significant enough to make fire mishaps too frequent during dry weather. Another fact is for paper to burn, a significant part of it must be elevated to a temperature of 200 degC. gives us another important clue.

Now, consider a sample of dry paper at 40 DegC. Let us take the specific heat of it as 0.25kCal/kg/degC. To raise temperature of 1kg of it by 160 degC, we need just 40 kCal energy. Now, if say the paper moisture is 10%, we'd need 36 kCal to heat the paper, plus nearly 70 kCal to evaporate and raise temperature of water contained in it, in form of moisture; thus totaling 106 kCal.

That means while to burn 1 kg dry paper you need to supply 40 kCal, while for paper having 10% moisture, you need 106 kCal energy. Evenif you are able to maintain moisture to just 5%, you'd need nearly 73 kCal energy. This shows the significance of ensuring a minimum safe moisture limit for paper.

The Climate

Most of the fire mishaps seem to occur during summers. But, if we analyze data carefully, we can find that that humidity plays a much bigger role in fire mishaps compared to temperature. The recipe for fire disaster starts with dry paper, dry weather, and something else to initiate the process.

Initiation of Fire

The fire can initiate when a small part of paper catches fire due to any external event. First of all, an initiation of fire has to be take place. How? Most of the paper mill workers and others associated with paper understand well the importance of fire safety, and hence negligence must not be the primary cause. In most of the open storage areas, one can be pretty sure about absence of an electric spark. I am, here, not just ignoring these two causes, but trying to explore some other possibilities.

Now, we can see that when the atmosphere is dry, paper becomes dry and adjacent air is also dry, this makes a dangerous combination. In case of wind blows, a spark may take place by itself; or it may appear by any other unpredictable reason.

Static Electricity

In fact, static electricity can be strong enough to start combustion at any places. Due to low humidity, air becomes good insulator, and restricts the balancing of charge by slow rearrangement of electrons. When air is moist, papermakers face reduced problems due to static charge- all tissue paper makers or those who are making paper grades of low basis weight can verify this.

The Spark Trial:

Please do have a look at the spark created by a simple kitchen lighter. The spark is strong enough to start flame on the gas burner. But, can it initiate flame in paper? In fact, several trials made on paper yielded in no result. However, the experiment was once repeated during dry weather, with old newspaper in place of copy paper used earlier. This time, the paper started burning. That indicated that dry paper, under dry climate can catch fire just by a small spark.

Similarly, concentrating sun rays using a magnifying glass can be used to burn paper. Many of us have done this experiment in our childhood. Such situations, though rarely, may create by the reflection from window panes etc.

Propagation of Fire

So, we need the external event as well as right conditions for fire to spread out. Here, right condition means conditions to availability of combustible material as well as air. It would be interesting to understand it in detail using the image 6 as shown below-

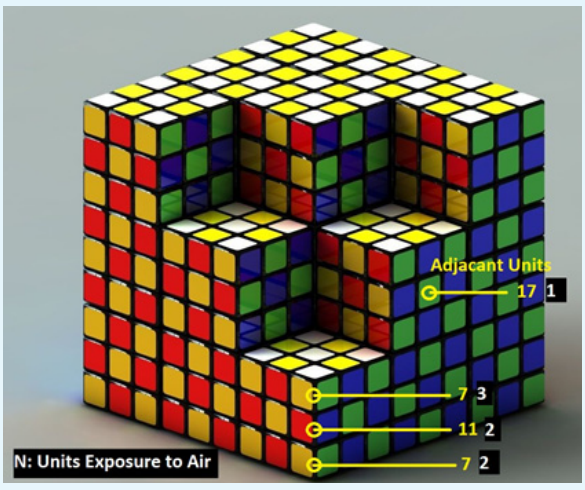

Image 6: A model of fire sensitive combustion prone block.

Any material can be considered as a three dimensional structure of different small units or cells. First of all fire initiates at a particular unit. Upon its incineration, the heat generated is dissipated to its adjacent units. In case there more adjacent units like in the one shown in figure (17 adjacent units), the heat is dissipated to 17 units, and hence, propagation of fire will not be that easy. The generated heat will be divided to these 1 units, so each unit will get relatively less heat. Compared to it, some other cells like those having 7 adjacent units; all of the heat generated shall be dissipated to only 7 units, thus making them under more risk of fire propagation.

Similarly, we can see that the bottom most marked unit has availability of oxygen from two sides, while to top highlighted unit has relative less oxygen available (one side only) for combustion. This obviously justifies the need to make our storage more and more compact and small. If we can stop or at least reduce air supply to the exposed sheet, it would be additional advantage.

Image 6 also highlights another important point. As the risk of fire hazard is more on the exposed surfaces, it is more important to ensure exposed surfaces have maximum moisture content always. Spraying water to ensure inside of waste paper is also wet is not very necessary. This, however, may help a little by slowly releasing moisture from inside to outside towards the surface. In this way, this increases surface moisture in a sustained way.

Misting

Now, the issue is- Can we really control a desired humidity level in nearby atmosphere? Can we maintain that particular moisture level in paper so that it acts as a retardant to fire?

Many mills use water spray over the waste paper in summer season. However, most paper professionals fear of degradation in paper quality due to repeatedly wetting and drying of paper. Mills using white grades of raw materials find the brightness reductions while the kraft based mills observe reduction in strength of paper due to frequent water spraying on waste paper stock.

Well, in such cases, the use of misting system could be a potential solution. Misting can be done over the waste paper, and alternatively on the adjacent areas which would do reduce the ambient temperature in the vicinity of waste paper, as well as over a period of time, the moisture content of paper will go up.

A few photographs of the misting system are being included here to have an idea-

Image 7 and 8: Misting example and protecting paper and waste paper from fire. (Image courtesy: Google)

Conclusion:

For better fire risk minimization, it is necessary to understand about paper, combustion properties of paper and air; and accordingly take preventive actions to avoid initiation of fire itself. Use of water misting directly at waste paper or nearby roads and other open areas also can help a lot. In closed areas like finished paper godown, artificial means of humidity management might be explored.

In addition, further research is strongly recommended on the following topics-

- Combustion rates of paper under various humidity levels
- Effect of moisture on combustion rates of paper
- Modeling of waste paper storage fire initiation and propagation rates
- Development of water mist spray systems for open waste paper storage areas
- Development of outdoor humidification systems for areas around paper storage
- Development of humidity control systems for finishing house and godowns

Let's initiate working together towards a **–no fire accident-** goal for paper industry.