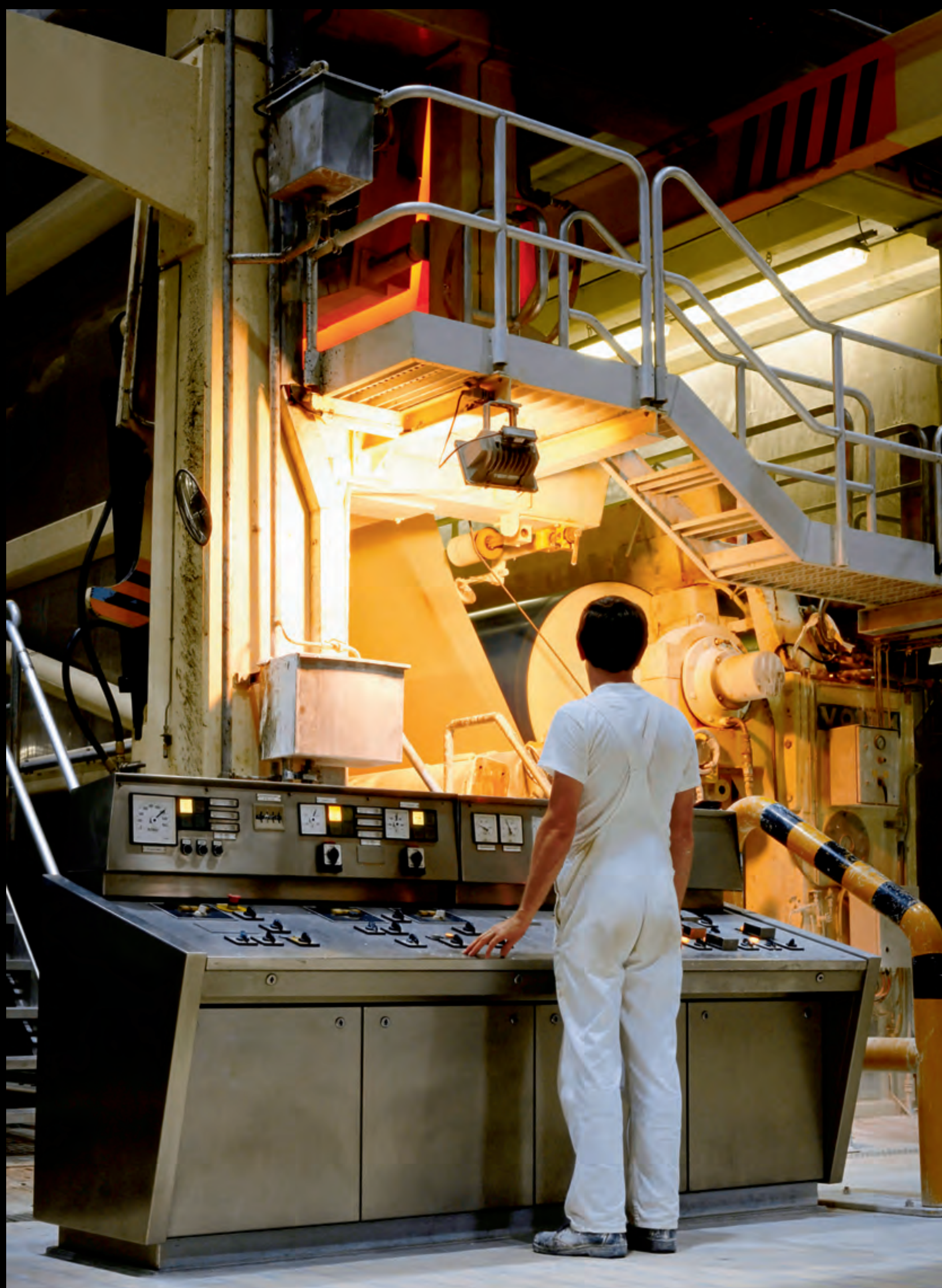
World Pulp & Paper

THE INTERNATIONAL REVIEW FOR THE PULP AND PAPER INDUSTRY



2016

Solving Volatile Fatty Acids Issues in Recycled Packaging Operations

By **David R Jones,** Industry Specialist, Buckman

INTRODUCTION

All grades of paper can have a problem with odour. The problem can be in the paper or as part of the operation. The cause of odour problems fall into two main groups: chemical and microbiological. The microbiologically-caused problems occur more often than the chemical- and this is especially so with recycled packaging grades. When investigating an odour problem, an understanding of the possible causes is important. There are various lab methods to identify the odour forming gas. Identifying the source of the odour is an important first step in the problem solving process. Once the source has been identified then a solution can be implemented. The solution can include process changes as well as a treatment program. This article focuses on volatile fatty acids (VFAs) and the issues they can cause in recycled packaging grades.

RECYCLING PACKAGING

When looking at the packaging industry as a whole, VFAs are more of a problem in 100% recycled operations. If you think about the pulps used in virgin packaging such as unbleached kraft, NSSC and sulphite, it is clear that the pH and temperatures that are used in these processes result in good microbial control. With old corrugated containers (OCC) you have a number of factors that result in more microbial contamination. These include outdoor storage and single stream recycling. With single stream recycling there is more chance of the recovered board to be contaminated with food matter. The food matter will contain microorganisms and also serve as food for the microbes.

The other factor that has led to more VFA issues is the tightening or closing up of water systems in packaging mills. As packaging companies look to reduce fresh water use, save energy and reduce effluent there is less and less opportunity to remove or wash out undesirable compounds. This is a factor that affects all types and grades of pulp and paper.

VOLATILE FATTY ACIDS

What are VFAs and where do they come from? VFAs are fatty acids with an aliphatic tail of less than six carbon atoms. Table 1 lists the various VFAs and the odours they produce.

The most common types of VFAs found in recycled packaging operations would be acetic, propionic and butyric. Many different types of bacteria can produce VFAs; these include both facultative and strict anaerobic bacteria. Facultative anaerobic bacteria can survive with or without oxygen while strict anaerobes thrive in no or low oxygen conditions.

Identifying the source of the odour is an important first step in the problem solving process. Once the source has been identified then a solution can be implemented

One example of a VFA producing bacteria is the *Clostridium* genus. These are obligate anaerobes, meaning that oxygen is toxic to them. They are also endospore formers. Some bacteria form an endospore; this is a spore that is formed inside the bacterial cell that contains the genetic material. This spore is released when the cell dies and is very resistant to hostile environmental conditions. They will survive prolonged boiling for example. Once conditions are again favorable to the bacteria`s growth, the spores wake up and start to grow. The presence of endospore forming bacteria is a factor that needs to be considered in a control program.

What are the issues that can be caused by VFAs? These fall into a few areas; the first is odour, which can be in the final product or in an area. There can be complaints from neighbours or from the workers in the mill. Odour in the final product can be a very serious issue that can lead to loss of business and can put a mill`s future in jeopardy. Some packaging customers have limits on the VFA level in the sheet that need to be met by the board producer.

DIAGNOSTIC METHODS

In problem solving any odour issue, you first need to determine the type of gas or gases that are producing the odour. There are various tests that can be done

Common Name	Systematic Name	Odour
Formic acid	Methanoic acid	Pungent solvent like nail polish
Acetic acid	Ethanoic acid	Vinegar
Propionic acid	Propionic acid	Body odour
Butyric acid	Butanoic acid	Rancid butter, vomit
Isobutyric	2-Methylpropanoic acid	Rancid butter
Valeric	Pentanoic acid	Fruit like
Isovaleric	3-Methylbutanoic acid	Body odour

Table 1. *Volatile Fatty Acids*

in a lab. For example, a gas sample can be tested with gas chromatography mass spectrometry using thermal desorption, and the resulting spectra is compared to a database to determine which gases are present. There are odour panels and professional smellers. These are people who have trained themselves to be able to identify different odours. There are many references in the literature that give more information on methods. There are monitors available that can detect gases and identify them. In some cases these can be programmed to store an odour's profile in memory.

If there is a limit to VFAs in the final product in most cases these samples are sent to an outside lab for testing. In the mill there are commercially available test kits to test for VFAs in stock and water samples. While the final product testing may be required, the in-mill test can be used as a monitoring tool. The in-mill test will give immediate results while the outside lab test will have a time delay.

The other area of testing is the microbial enumeration or detection methods. It is important to understand the nature of microbial testing. There is no one test that will test for all the different types of microorganisms, especially with odour where it is important to identify the different types of microbes that are causing the odour. When in the problem solving stage a number of different tests may be necessary to help identify the microbes present and audit the system. This article will not discuss in detail the wide range of tests available but will focus on the VFA producing anaerobic bacteria. A common test for bacteria is what is commonly known as the standard plate count. This widely used method tests for aerobic bacteria which will grow on nutrient agar at a temperature of 36 °C. Therefore, if you are looking for anaerobic bacteria this test will not detect them. You need to use a more specific test such as using reinforced clostridial medium. This tests for clostridial species as well as some other anaerobic bacteria. It is more a yes/no test in that you do not end up with a count of the population.

Improving process conditions… is important, but in the case of VFA control this will not provide the complete answer

CONTROL OPTIONS

It was mentioned earlier that in most cases a control program will involve process changes as well as the use of a microbial control program. In the case of anaerobic bacteria, a good control tool is oxygen. Improving mixing in chests and tanks to keep oxygen levels up will help control the anaerobes. This is an economical option. Good cleaning and housekeeping is also important. If a layer of solids is allowed to build up in the bottom of a chest then anaerobic conditions can result. The aerobic bacteria in the layer will use up the oxygen. Once the oxygen level is low then anaerobic bacteria growth will start. In the same vein leaving water and pulp sitting unused in tanks should be avoided. Again this can lead to anaerobic conditions. It is always important to audit the process to identify unfavorable process conditions and, as much as possible, to design them out or at least minimise them.

Improving process conditions as mentioned above is important, but in the case of VFA control this will not provide the complete answer. A microbial control program will be required. One aspect of VFA producing anaerobic bacteria control is the endospores that were mentioned earlier. A portion of an endospore producing bacterial population will always produce endospores. One bacteria will produce one endospore. When environmental conditions become more hostile then the percentage of the population that produce an endospore will increase. The result is that you could kill all of the living bacteria and leave the endospores. Once conditions are again favorable for bacterial growth the same problem will occur.

Choosing the right type of control program is important. There are two main types of biocides, the organic based and inorganic. The organic products contain an active that is toxic to microbes. It is important to choose the right active for the type of microbe that needs to be controlled. A biocide active that is very effective at reducing an aerobic bacteria population may have little effect in reducing the population of an anaerobic bacteria. Thus, it is important to choose the right active or actives for the type of microbe that needs to be controlled. Application program design is also important. Flow rates have to be set so that the kill concentration for that specific active is reached. In addition, some actives require more contact time to be effective and this needs to be reflected in the biocide application strategy. One of the downsides in using organic biocides is that they may not penetrate the biofilm to reach the anaerobic population. Also they may not be able to penetrate a pulp build-up at the bottom of a chest. Buckman has the required information for all of the actives in our biocide product line and uses computer models to determine cycling up of the product to ensure that the effective concentration is reached.

Inorganic microbicides are mainly in the chlorine family; different types include chlorine gas, hypochlorite and chlorine dioxide. There are also products such as peracetic acid and peroxide. The chlorine products can be effective but there are limitations especially in a packaging operation. The chlorine products are oxidisers. They will oxidise organic matter, inorganic reducing matter and biological matter (including bacteria). They have to satisfy the total demand to be effective. For recycled packaging mills, the demand will be higher than that found in a 100% virgin bleached kraft fine paper operation. The result is that the traditional inorganic products can be expensive and less than effective.

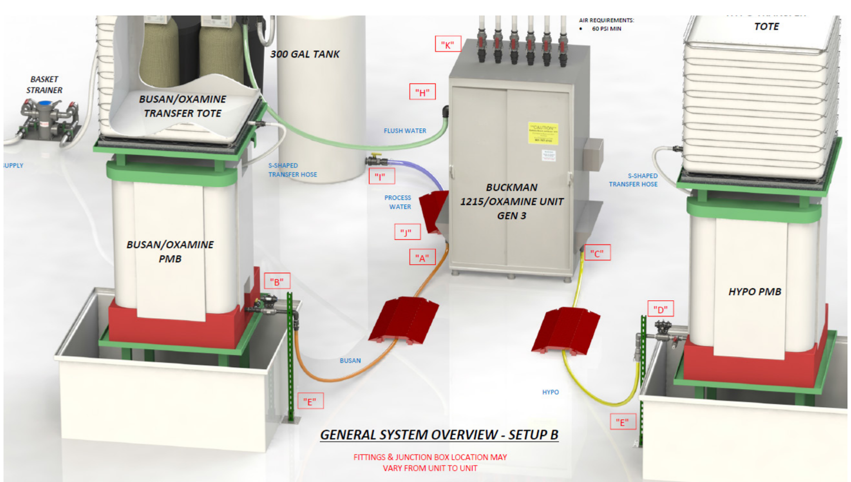


Figure 1. *Oxamine Feed System*

When environmental conditions become more hostile then the percentage of the population that produce an endospore will increase

OXAMINE®

Buckman's Oxamine family of products can be used to control microbes. The Oxamine products are a proprietary mixture of ammonium compounds that, when mixed with hypochlorite at precise molar ratios and the correct pH, produce the biocidal active. Because Oxamine is already combined, it is not affected by the typical oxidant demand of the system. The active itself is biocidal and is able to greatly reduce the population of both aerobic and anaerobic bacteria.

The precise mixing of the two components is extremely important to safely produce the required active. If the correct molar ratio is not maintained then other compounds can be produced that are not biocidal. Buckman has developed a PLC controlled, sophisticated feed system that maintains the correct ratio to ensure that the biocidal active is produced. In addition, it is important that the Oxamine® and hypochlorite do not mix together in the neat form as this can produce toxic gases. Both products are mixed with water in the system to safely produce the desired active. The feed system has a solid partition in the middle. The Oxamine(r) and hypochlorite are separated by this partition. If there is a leak in the system, the two neat products cannot get into contact with each other.

The feed system is designed with safety first in mind. The system includes:

- Pre-rinse and post-rinse cycles
- Alarms that trigger wash sequence and shutdown
    - Low/high/no chemical flows
    - Low or no dilution water flow
    - Loss of air pressure
    - Loss of power
- Emergency rinse in case of power failure
- Leak-proof casing with integrated spill sensors
- Back-up water source for emergency flushing

Thus, if there is any interruption in operation the system will automatically shut down and flush. Figure 1 is a diagram of an Oxamine feed system.

Traditional chlorine products are controlled to a free chlorine measurement. In the case of Oxamine, a total chlorine measurement is used. An example is an alarm in the system that will send a text to a Buckman associate or to mill personnel, informing them of the alarm.

Case Study 1

A 100% recycled packaging mill was receiving complaints from neighbours about odour coming from their effluent plant. The odour included VFAs. An Oxamine program was started and there has been a marked reduction in complaints over the period of one year.

Case Study 2

A 100% recycled packaging mill needed to be below a target VFA level in some of their board grades. An Oxamine program was started that treated both the pulp and the water system. ATP measurement showed a tenfold decrease in total microbial population, and final product testing confirmed that the VFA levels were well below target.

Case Study 3

A mill needed to reduce the VFA levels in their final product. An Oxamine program was started and there was an almost immediate reduction in VFAs. Chart 1 shows the results. Another benefit of this program was that odour in the mill was reduced.

CONCLUSION

Odour problems in pulp and paper take many forms. Volatile fatty acids are becoming more of an issue in recycled packaging operations. The two main reasons for this include the use of recycled paper with its contamination and the closing up of water systems. Both of these result in higher microbial populations. Problem solving involves a good understanding of the various causes of odours, and the testing methods that are required to identify the type of odour and its source.

In the past various organic and inorganic type microbicides were used to control VFAs; they could be expensive and not always effective. The introduction of Oxamine® by Buckman has given the recycled packaging operation a tool that can effectively control VFA levels, whether it is an odour issue or a final product requirement. Buckman has safe, well designed feed systems to ensure the correct and safe application of Oxamine. Oxamine has proven effective in controlling a wide range of microbial issues including VFA control in a number of recycled packaging mills.

Problem solving involves a good understanding of the various causes of odours, and the testing methods that are required to identify the type of odour and its source

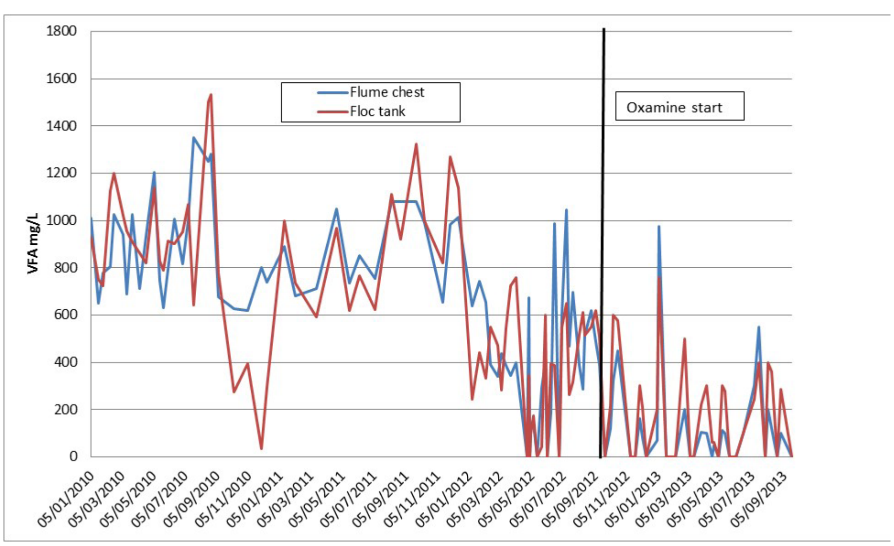


Chart 1. *Case study 3, VFA levels*