WHITE PAPER
MODIFIED ATMOSPHERE PACKAGING

The White paper is made in collaboration between MOCON Europe (Dansensor) and Campden BRI. Author is Alan Campbell, food & packaging technology specialist at Campden BRI.

Content:

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MODIFIED ATMOSPHERE PACKAGING
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What is MAP?

Modified Atmosphere Packaging (MAP)
relates to placing of a foodstuff in:

- a sealed pack and either gas flushing with a pre-selected gas mixture before sealing

- or allowing the product to change the gas mixture itself

Once the package has been sealed there is no control of the gas mixture inside.

Vacuum packing can also be considered as a format of MAP as the process of drawing a vacuum will remove all headspace gases thereby resulting in a modified pack with no oxygen present.

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food and drink innovation

MOCON Europe A/S
Rønnedevej 18
4100 Ringsted, Denmark
Tel +45 57 66 00 88
sales.dk.mocon@ametek.com
www.dansensor.com

MODIFIED ATMOSPHERE PACKAGING QUALITY CONTROL

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What should be tested when using MAP?

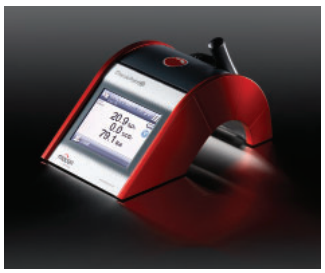
The gas headspace within the pack should be tested for the mixtures used. Gas analysers will generally provide results for oxygen and/or carbon dioxide. The analyser will report nitrogen by difference rather than testing its presence.

The oxygen analyser gives an indication of level of oxygen present or residual oxygen if the product is to be packed without oxygen. This type of analyser is always used when flushing the pack with suitable food safe gas as it will indicate the effectiveness of the flush by showing the level of remaining oxygen present. A low level of oxygen will always remain and levels of less than 0.8% are seen to be acceptable.

If using carbon dioxide as part of the gas mixture then the analyser must be capable of detecting its presence. The packer needs to be sure that the gas mixture including carbon dioxide is at the correct proportion at time of packing. To comply with this requirement the levels of both carbon dioxide and oxygen present need to be identified.

For vacuum packed products it is not possible to test the headspace. However, the tightness of the packaging surrounding the product should be checked to ensure that the correct vacuum has been achieved.

Dansensor® CheckMate 3 headspace gas analyser



Dansensor® CheckPoint 3 handheld headspace gas analyser

How frequently should be tested?

The gas mixtures within the MA packs must be tested at least on start and end of production. Frequency of testing during production should ideally be the equivalent of other checks such as weight control and pack integrity.

By undertaking a series of smaller checks the packer is more likely to identify variations which could affect the safety and/or quality of the product, i.e. for longer runs, testing should ideally be undertaken at hourly intervals if not half-hourly. The use of on-line analysis and control systems can be a useful addition as they will monitor the gas mixture on a continuous basis and stop the machine if anything is detected as being out of specification. As off-line testing is generally a destructive test a balance needs to be achieved between the cost of the samples and the cost of not testing effectively.

Additional checks should also be considered when an incident has occurred on the packing line. These incidents may be simple such as changing the packing film or may be more complex such as cleaning the machine and resetting the sealing jaws after product "pile-up".

How big a sample population should be tested?

Good practice suggests that as a minimum samples should always be tested in duplicate. A series of smaller more frequent checks is better than a larger check at beginning and end of production run. Sampling of the batch will never indicate that the batch is free from defects. All that sampling will allow is that it will give a level of confidence that the batch is acceptable. For example, it is necessary to test 300 containers to be sure of finding a defect level of 1 in 100. Similarly it will be necessary to test up to 30,000 containers to find a defect level of 1 in 10,000. Statistically this will equate to a confidence level of 95%. On thermoforming and traysealing machines it is recommended to test a full cycle to find any tooling defects.

On the next page a table shows the percentage of tested products at a certain packaging speed and random test frequence.

MOCON Europe A/S
Rønnedevej 18
4100 Ringsted, Denmark
Tel +45 57 66 00 88
sales.dk.mocon@ametek.com
www.dansensor.com

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Packaging Machine Speed (number of packages / minute)

Number of manual tests per hour	60	70	80	90	100
1	0,03%	0,02%	0,02%	0,02%	0,02%
2	0,06%	0,05%	0,04%	0,04%	0,03%
3	0,08%	0,07%	0,06%	0,06%	0,05%
4	0,11%	0,10%	0,08%	0,07%	0,07%
5	0,14%	0,12%	0,10%	0,09%	0,08%
6	0,17%	0,14%	0,13%	0,11%	0,10%
7	0,19%	0,17%	0,15%	0,13%	0,12%
8	0,22%	0,19%	0,17%	0,15%	0,13%
9	0,25%	0,21%	0,19%	0,17%	0,15%
10	0,28%	0,24%	0,21%	0,19%	0,17%
11	0,31%	0,26%	0,23%	0,20%	0,18%
12	0,33%	0,29%	0,25%	0,22%	0,20%
13	0,36%	0,31%	0,27%	0,24%	0,22%
14	0,39%	0,33%	0,29%	0,26%	0,23%
15	0,42%	0,36%	0,31%	0,28%	0,25%
16	0,44%	0,38%	0,33%	0,30%	0,27%
17	0,47%	0,40%	0,35%	0,31%	0,28%
18	0,50%	0,43%	0,38%	0,33%	0,30%
19	0,53%	0,45%	0,40%	0,35%	0,32%
20	0,56%	0,48%	0,42%	0,37%	0,33%

Off-line testing vs. on-line testing?

There is a wide range of equipment used for testing. When setting up the production line it should be possible to use a smaller bench or hand held gas analyser to ensure the mixture is correct.

The use of off-line equipment is best suited to smaller businesses that are undertaking relatively short production runs on a range of gas mixtures or using smaller gas flushing equipment.

The selection of which off-line analysis equipment to use will depend on the environment and location of office/ laboratory in relation to the production area. Hand-held equipment is cheaper and smaller but due to its portability could be more susceptible to damage such as dropping. A bench mounted analyser will prove more robust plus may also have the facility of an in-built printer. Both types can be linked to computer systems with the correct cable connections.

For larger business with multiple higher speed production lines it is possible to use in-line gas analysers which also have the capability of testing and correctly adjusting the gas flush in order. The use of in-line gas analysers ensures continuous process control and can reduce packaging waste and save gas on vertical and horizontal form-fill and seal machines.

In general random sampling can create a lot of repackaging and waste of packaging material, below table gives an overview of the number of packages wasted yearly at a certain number of samples per hour.

MOCON Europe A/S
Rønnedevej 18
4100 Ringsted, Denmark
Tel +45 57 66 00 88
sales.dk.mocon@ametek.com
www.dansensor.com

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Number of working hours per day / days per year

Number of manual tests per hour

	14 hours / 250 days	16 hours / 250 days	8 hours / 250 days	10 hours / 250 days	12 hours / 250 days
6	21,000	24,000	14,400	18,000	21,600
7	24,500	28,000	16,800	21,000	25,200
8	28,000	32,000	19,200	24,000	28,800
9	31,500	36,000	21,600	27,000	32,400
10	35,000	40,000	24,000	30,000	36,000
11	38,500	44,000	26,400	33,000	39,600
12	42,000	48,000	28,800	36,000	43,200
13	45,500	52,000	31,200	39,000	46,800
14	49,000	56,000	33,600	42,000	50,400
15	52,500	60,000	36,000	45,000	54,000

Leak detection?

Packing foods in a modified atmosphere means that the pack integrity has to be well maintained. Any hole or leak in the pack can have an undesirable effect on the quality and safety of the pack contents. The pack seals need to be checked at the same frequency as other quality checks.
The testing could be a simple visual check or possibly a "squeeze" type test next to the sealing machine. Additional testing procedures could be undertaken by off- line laboratory integrity checks using the same packs as used for gas analysis.

There is more specialised non-destructive testing equipment available which is capable of testing for specific gas leakage such as CO_2. This testing can be undertaken in batches off-line or on a continuous basis on-line.

Dansensor® LeakPointer 3 and LeakPointer 3+ - Off-line leak detection unit based on CO_2 as trace gas

What are the EU requirements for labelling etc?

Gases which are permitted to be used in packaging applications have been allocated their own unique E-number as food additives. These are listed in EU Regulation 1130/2011 (PART 3 - Food additives including carriers in food enzymes). They listed below for reference.

E 290 - Carbon dioxide
E 938 - Argon
E 939 - Helium
E 941 - Nitrogen
E 942 - Nitrous oxide
E 948 - Oxygen
E 949 - Hydrogen

The use of carbon monoxide as a packaging gas is not permitted within the EU.

Where the packaging gases have been modified then there is a requirement to make this information available on the label. EU Regulation 1169/2011 (Annex III) requires foods packed in certain gases to be labelled with the words.

"PACKED IN A PROTECTIVE ATMOSPHERE".

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Are there specific requirements from the retailers?
The major European retailers all subscribe to auditing standards benchmarked to GFSI. The major European standards in use are BRC, IFS, FSSC and AIB.

Within the standards there are both technology requirements as well as traceability requirements.

The BRC Food (V6) standard covers gases used in MAP in section 4.5.4. It states "Air, other gases and steam used directly in contact with or as an ingredient in products shall be monitored to ensure this does not represent a contamination risk. Compressed air used directly in contact with the product shall be filtered".
By reference to the guidance document supporting the BRC (V6) indicates that the quality of gases used should be appropriate. The site would not be expected to undertake checks on cylinder supplied gases as supplier approval and certification would be sufficient. Where gases are produced on site their manufacture should be evaluated through risk assessment.

The IFS standard is not as specific with regards to MAP gases but does cover the use of compressed air in contact with food. Section 4.9.10 indicates that the use of compressed air should be monitored based on a hazard and risk analysis. Where other gases are used this section could be used as guidance of the requirements.

Other standards such as FSSC and AIB similarly do not specifically cover MAP gases. They do indicate that the use of compressed air in contact with food should be based on a suitable risk analysis.

BRC – British Retail Consortium
BRC Global Standards is a leading safety and quality certification program, used by over 20,000 certificated suppliers in 90 countries, with certification issued through a worldwide network of accredited Certification Bodies.

http://www.brcglobalstandards.com/#

IFS – International Featured Standards
IFS Standards are developed for and through all involved parties in the supply chain, which would like to use uniform standards to ensure safety and quality of food and non-food products and related services.

http://www.ifs-certification.com/index.php/en/

FSSC – Food Safety System Certification
The Foundation for Food Safety Certification was founded in 2004. The Foundation developed FSSC 22000, the ISO 22000 and PAS 220 based certification scheme for certification of food manufacturers

http://www.fssc22000.com

AIB International American Institute of Bakers
AIB provides Food Safety Inspections, Audits, and Certifications, Food Safety Education, and Research & Technical Services

https://www.aibonline.org/

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HACCP

Does MAP have specific CCP´s?
The hazards of using MAP relate to the type of food and the gas mixture used. There are specific food safety hazards associated with low oxygen atmospheres and vacuum packed products where it is possible under specific conditions to allow for the growth of Clos. botulinum with toxin production on storage.

The majority of hazards associated with MAP relate to quality. The gas mixture within the pack has been selected to extend the chilled shelf life of the product by a number of days. If the mixture changes or leaks out then the shelf life will be reduced. Quality deterioration will be noticeable in the first instance.

The loss of specific gases may allow the growth of pathogen to increase more rapidly than if the product retained its desired atmosphere.

What measures should be setup to ensure these measures?
The food business should include the MAP process as part of the overall HACCP plan. This should clearly identify the reasons for the use of the selected gas and the effects of its failure. Additionally, the document should specify how the gas mixture will be controlled, how the package integrity is controlled and any checks that are to be used.

What are the best practice procedures for a MAP manufacturer?
The control steps should be clearly identified with regular monitoring of the gas mixture being undertaken. The measures should include for the occasions when the mixture does not meet the required standard and the actions to be taken should be clearly detailed within the documentation.

Dansensor® MAP Check 3 on-line gas analyser for flow packaging machines

MOCON Europe A/S
Rønnedevej 18
4100 Ringsted, Denmark
Tel +45 57 66 00 88
sales.dk.mocon@ametek.com
www.dansensor.com

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IFS, BRC, ISO

What will auditors look for?
Auditors will be looking to see how the hazards have been identified and then addressed within the HACCP documentation. In addition, the auditor will want to see any supporting documentation and records such as monitoring of control points.

What data is required?
For the gases supplied by cylinder the auditor may request to see all the records associated with the selection and approval of the gas supplier and any certificates related to the quality and safety of the gases supplied. The site would not be expected to undertake checks on cylinder supplied gases as supplier approval and certification would be sufficient.

Where gases are produced on site (normally nitrogen) then the risk analysis should cover the process. As with any gas supplied for food contact application it should be filtered before use. The documentation should include any filtration system and pore size used.

All data should be securely stored either electronically with suitable backup or as a paper based original. Where amendments have been made to these data they should ideally be dated and initialled by the person making the alteration. Additionally the original information should still be legible.

Data should be stored as a minimum for the shelf life of the product taking into account that customers may extend the product shelf life by freezing. A reasonable suggestion is that records are retained for the shelf plus twelve months to allow for any anomalies as per the requirements of other production records such as weight control.

What about calibration/validation of measuring equipment?
Records related to both the initial validation and subsequent regular calibration checks need to be maintained showing how and when they undertaken along with any appropriate results.

Validation can be described as the process undertaken by the food business when setting up and establishing the packaging operation. This process will ensure that the correct gas mixture is being used and is suitable for the application.

Calibration on the other hand relates to ensuring that the gas mixer and gas analysing equipment are working correctly and are capable of delivering the correct gas mixture through out the production process.

Where gas mixers are being used to supply blends of gases then the mixer needs to be checked on a daily basis using a system similar to that used to calibrate the analyser.

The majority of analysers have an inbuilt calibration stage which checks the air in the environment surrounding the equipment. The result would normally be that for atmospheric air (20.9% oxygen, 0.04% carbon dioxide with balance 79% nitrogen).

Certificated calibration gases are available if required. Their use should ideally be limited to master calibration normally undertaken during servicing of the analyser by the equipment supplier.

MOCON Europe A/S
Rønnedevej 18
4100 Ringsted, Denmark
Tel +45 57 66 00 88
sales.dk.mocon@ametek.com
www.dansensor.com

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TRACEABILITY –

(EU REGULATION 178/2002 - ARTICLE 18)

What is required?

All products produced and sold within the EU are required to be traceable from point of manufacture or entry in the EU through to the final customer. The EU regulations are specific in that they require not only the food but also any other substance which may be used. This can be considered to include packaging gases. The traceability of packaging (food contact) materials is covered by other EU regulations.

While there is a requirement for the supply chain to demonstrate traceability it is up to each stage to be able to show where the product was obtained and to whom it has been supplied, i.e. one up and one down.

Systems need to be in place to demonstrate traceability to both the authorities and customers when required.

How should data be stored?

There must be recording systems in place showing at least the suppler, date of receipt and date of use. In addition the system should identify which businesses have been supplied with materials made from those deliveries. This traceability should include gas supplies where appropriate.

It would be good practice to extend the traceability such that any individual batch of product can be identified if required.

MOCON Europe A/S
Rønnedevej 18
4100 Ringsted, Denmark
Tel +45 57 66 00 88
sales.dk.mocon@ametek.com
www.dansensor.com

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BASIC QC/QA PROCEDURES FOR MAP MANUFACTURERS

Example of simple check sheet used for MAP production:

Date	Time	Packaging Line No.	Product No.	Product Name	O_2 ResultC	O_2 Result	Barcode check	Leak Test	Operator initials

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MOCON Europe A/S
Rønnedevej 18
4100 Ringsted, Denmark
Tel +45 57 66 00 88
Fax +45 57 66 00 99
sales.dk.mocon@ametek.com
www.dansensor.com

MOCON, Inc.
7500 Mendelssohn Ave. N.
Minneapolis. MN 55428 USA
Tel +1 763 493-6370
Fax +1 763 493-6358
info.mocon@ametek.com
www.mocon.com

AMETEK INSTRUMENTOS, S.L.U.
Esteve Terradas, 31 - Local 9
08023 Barcelona, España
Tel +34 93 2052286
Fax +34 93 2804027
info.es.mocon@ametek.com
www.dansensor.es

AMETEK GmbH
Carl-Borgward-Straße 10
56566 Neuwied, Deutschland
Tel +49 2631 3933 0
Fax: +49 2631 3933 33
sales.de.mocon@ametek.com
www.dansensor.de

AMETEK S.A.S
14 rue de Ris
91170 VIRY CHATILLON, France
Tel +33 1 69 56 58 50
Fax +33 1 69 56 58 51
info.fr.mocon@ametek.com
www.dansensor

AMETEK S.r.l.
Via della Liberazione, 24
20068 Peschiera Borromeo (MI), Italia
Tel.: +39 02 946931
info.it.mocon@ametek.com
www.dansensor.it

Read more about MAP on:
www.dansensor.com
www.modifiedatmospherepackaging.com
www.campdenbri.co.uk

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MOCON Europe A/S
Rønnedevej 18
4100 Ringsted, Denmark
Tel +45 57 66 00 88
sales.dk.mocon@ametek.com
www.dansensor.com