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REPORT ABOUT THE TESTING ON PLASTICS BIG PACKS FOR BEVERAGES

Test report no:	VP-TR-580/09
This test report consists of:	16 pages of text
Client:	KHS GmbH
Test item:	Plastics Big packs
Date of sampling:	No declaration
Location of sampling:	No declaration
Sampling plan:	No declaration
Sampling procedure:	No declaration
Date of receipt of sample:	09.09.2009
Dates of duration of tests:	10.09.2009 - 25.03.2010
Test characteristics:	Test of oxygen item, loss of carbon dioxide, micro biology and physical parameters
Test method:	VLB, DIN, MEBAK, EBC
Journal-Nr.:	580/09
Producer :	**Petainer UK Holdings Ltd.**
Products (statement):	**Petainer Keg™, 20 l, brown**

Deutscher Akkreditierungs Rat DAR
Registriernummer DAP-PL-3006.00

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The accreditiation is valid only for the test methods mentioned in the document.
In the operating procedures specified uncertainties are kept.**

**The own test methods are marked with <VLB> and can be looked into by request.
The test results relate only to the items tested.
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1 Terms of Reference

The Petainer UK Holdings Ltd. has developed a new one-way keg. The PET-container is a lightweight one-way alternative to the steel keg. The Petainer Keg™ is used for draught packaging of beer, wine and other beverages.

The Testing Laboratory for Packaging of the Versuchs- und Lehranstalt für Brauerei in Berlin (VLB) e.V. (Research and Teaching Institute for Brewing in Berlin) was entrusted to test whether the Petainer Keg™ is suitable for draught packaging of beer and stocking periods of at least six month. In order to do so the following parameters had to be checked:

- Dimensional stability and volume consistency
- Filling volume
- CO_2-loss with stocking at increased temperature
- Tightness tests with short-term stocking at increased temperature
- Drop test
- Stacking weight pressure consistency at increased temperature
- CO_2-loss and O_2-uptake within a 6 months period
- Microbiological test

Detailed descriptions of the individual trials and of the implied measuring methods can be found in chapter 3: Material and Methods. The VLB Berlin was authorised to carry out the tests by the KHS GmbH in order to obtain an impartial examination of the product protection characteristics of the Petainer Keg™. Sensory tests or comparisons with steel kegs did not take place.

2 Description of the Petainer Keg™

Build-up and Material

The Petainer Keg™ is a PET container that is available with a capacity of 20 litres and in the near future as a 30 litre container. The container itself is made of Polyethylenterephthalat (PET) with additives (Blend Technology). The additives are used in order to improve the barrier properties of the container jacket concerning carbon dioxide losses and take-up of oxygen. The brown colorimeter in the container jacket ensures that the bottled product is shielded against the impacts of light.

Apart from the PET-container itself the Petainer Keg™ includes a fitting and a spear, both of which are also made of plastic. The Petainer Keg™ is kept in a cardboard box in order to protect it against mechanical impact and light irradiation. The cardboard box also facilitates transport and stocking of the Petainer Keg™.

According to the manufacturer all used materials apply to international guidelines of (packaging) materials with food contact.

The Petainer Keg™ can be integrated in all current dispensing equipments for draught beer, the Petainer Keg™, like the Steel-Keg, is emptied with connected gas and the displacement of the liquid via spear. By the time the container is completely empty and free of pressure the Petainer Keg™ can be disposed in residual waste. The build-up of the keg is structured in a way that allows the separation of the various components into different materials that meet the requirements for recycling.

The Petainer Kegs™ that were used for the various tests and analysis were filled with the respective media (Pilsner Beer or carbonised water) in the Flensburger Brauerei.

Images 1 to 5 show the Petainer Keg™ in its empty stage and after having been filled. Image 6 shows the future version of the Petainer Keg™ that has a capacity of 30 litres and will be available before long. The 30 litres version of the Petainer Keg™ was not tested during these examinations.

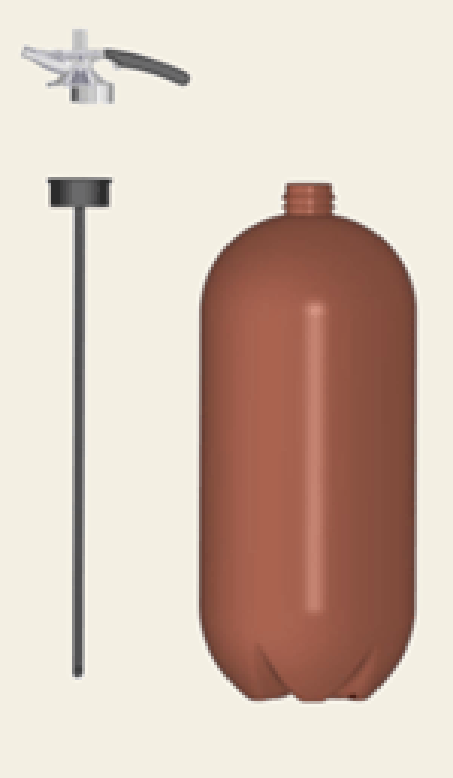

Image 1: Schematic design of the Petainer Keg™ (20 Litres) including:

- PET-Container
- Fitting with spear
- Tap head

Image 2: Petainer Keg™ components with cardboard packaging (20 l)

Image 3: empty Petainer Keg™ (20 l)

- Standard Flat fitting Type A

Image 4: Filling of the Petainer Keg™

- Filling machine Type Innokeg PETBOY-F2 (KHS GmbH)

Image 5: Pallet with filled Petainer Kegs™ with protective cardboard packaging

Image 6: Petainer Keg™ with 30 l filling volume

3 Materials and Methods

Chapter 2 describes the used test containers. For carrying out the various tests for this report filled and empty containers were used. The containers contained vented, carbonised water or Flensburger Pilsner beer.

After the transport to the Versuchs- und Lehranstalt für Brauerei in Berlin (VLB) e.V. the Petainer Keg™ was stocked under specified conditions. If not stated otherwise the stocking temperature was 21 ± 2 °C.

3.1 Volume consistency

In order to define the volume consistency we did measurements of the height, the maximum circumference and the changes in the filling level.

Image 7: Labelling filling-level changes

The measurements were carried out on arrival, a second and third measurement took place 24 hours and 7 days after the arrival of the samples. The level was measured with a universal material tester of Otto Wolpert-Werke GmbH. The maximum circumference of the keg was measured by using an appropriate calibrated metal measuring tape.

The filling-level was marked immediately after the filling. The filling-levels of the samples were also labelled on arrival and on two other measuring days, the procedure included also the

measurement of the differences between the markings using a calibrated length tester. Image 7 shows exemplary markings.

The volume consistency was checked on 10 Petainer Kegs™ that were filled with vented, carbonised water.

3.2 Filling volume

The filling volume was checked on 10 Petainer Kegs™ that were filled with vented, carbonised water.

In order to specify the filling volume the mass of the filled Petainer Kegs™ had to be measured in filled state and in empty state, the empty state measuring was carried out after emptying and air-drying the container. The filling volume of the Petainer Kegs™ was calculated from the difference between the two measured masses and the density of the water.

3.3 CO_2-loss with stocking at increased temperature

The CO_2-loss with stocking at increased temperature was tested on 3 Petainer Kegs™ that were filled with beer. The CO_2-measurement was carried out according to the method specified in 3.7. The base value for the procedure was the initial value for the CO_2-concentration specified in 3.7.

For the stocking at increased temperatures three Petainer Kegs™ were tested during a 7 days period in a climate chamber at a temperature of 30 ± 1 °C.

In order to stipulate the content of solved CO_2 within the beer the checking device c-DGM CO_2/O_2 content made by Norit Haffmans was used. The CO_2-loss is calculated as decrease by percentage of the starting value (24 hours after arrival of the samples).

3.4 Tightness with short-term stocking at increased temperatures

For the tightness tests during short term stocking at increased temperatures three containers filled with beer were held in a water bath, the containers were completely under water for 48 hours with a water temperature of 40 ± 2 °C. After 48 hours visual checks on the container for leaks and loss of liquid were carried out.

3.5 Drop test

The drop and impact resistance tests were carried out according to DIN 55441-2. A total of 3 containers filled with beer were tested. The drop height was 1.00 m. During the test the container was kept within its card board box.

3.6 Stacking weight pressure consistency

The stacking weight pressure consistency was tested on 3 Petainer Kegs™ filled with beer. To this end the three Petainer Kegs™ were uniformly loaded with a weight force of 400 N per container (image 8) over a 3 weeks period. The containers were stocked in a climate chamber with temperatures of 30 ± 1 °C.

Image 8: Test container with an axial loading of 400 N per container

3.7 Permeation behaviour– Carbon dioxide loss

The CO_2-loss tests were carried out with beer-filled test containers. The containers were tested 24 hours after arrival (initial value), after one month, after three month and conclusively after 6 months. The CO_2-content was checked in repeat determination at two containers a day.

In order to stipulate the content of solved CO_2 within the beer the checking device c-DGM CO_2/O_2 content made by Norit Haffmans was used. The CO_2-loss is calculated as decrease by percentage of the starting value (24 hours after arrival of the samples).

3.8 Permeation behaviour – Oxygen uptake

The oxygen take-up was tested at test containers that were filled with vented, carbonised water. The first test was carried out 24 hours after arrival of the test containers, afterwards the containers were tested monthly over half a year. The measurements of the O_2-content were carried out on stipulated days in repeat determination, each time on two test containers.

The tests on water-solved O_2 were carried out using the testing device DIGOX 6 made by Dr. Thiedig + Co. The oxygen content within carbonised water is stated as absolute value.

3.9 Microbiological Test

The microbiological analysis was carried out according to EBC Analytica Microbiologica II, chapters: 2.3.6 / 2.3.7 / 4.2.5.2 / 4.2.6 and according to MEBAK Bd. III, 2. print out, chapters: 10.6 and 10.11.

A total of 6 empty Petainer Kegs™ were tested.

4 Results and Discussions

4.1 Filling volume and Volume consistency

Table 1: Results of the tests on filling volume and volume consistency

Measuring / time	Specification	0 days.	1 day	7 day
Height (mm)	546	553.33	553.57	554.49
Circumference(mm)	738	746.3	746.5	746.8
Filling level (Δ in mm)	-	7.53	8.08	10.02
Full weight (kg)	-	-	-	20.3
Net weight (g)	-	-	-	287.0
Filling volume (l)	20.0	-	-	20.0

The specifications stated in table one were provided by the manufacturer (www.petainerkeg.com), they are referring to empty containers. Please note that there can be changes in the dimensions caused by internal pressure and room temperature.

The findings concerning volume consistency have shown that insignificant expansions of the Petainer Kegs™ occurred between the filling of the containers and their arrival at the Versuchs- und Lehranstalt für Brauerei in Berlin (VLB) e.V. The expansions amounted to an arithmetic average of 7 mm in the height and 8 mm in the circumference of the containers. The expansion led to an enlargement of the container volume and thus to a reduction of the filling height of about 8 mm at the arrival of the test containers. After a one week stocking at 21 °C only insignificant variations of about 1 mm in height and 0.5 mm in circumference could be observed. Thus a reduction of the filling height of a total of 10 mm compared with the height immediately after the filling could be registered.

The containers filled with carbonised water had an average mass of 20.3 kg. After emptying and drying the containers registered a net weight of an arithmetic average of 287 g, thus, considering the density of the water, the filling volume amounted to 20.0 litres, that meets the parameters of the manufacturers.

These minimal modifications in the dimensions of the containers are due to the physical properties of the container material and are acceptable if they remain below an absolute value of 2 % absolute. The filling volume is not touched by these modifications and corresponds with the given requirements.

4.2 Drop test

None of the 3 test containers filled with beer showed any loss in tightness or irreversible changes in shape during the drop test (drop height 1.00 m). Respecting the stocking instructions the tested containers thus passed the test according to DIN 55441-2

4.3 Stacking weight pressure consistency

None of the 3 tested containers showed any visible loss of its mechanic stability after a stacking weight pressure of 400 N per container during a 3 weeks period and at a temperature of 30 ± 1 °C. Visible changes couldn't be found either in height and extent of the container itself or on the cardboard box

Thus the stacking weight pressure consistency test with a burden of 400 N was successfully passed.

4.4 Tightness with short-term stocking at increased temperature

After a stocking period of 48 hours in a water-quench with a temperature of 40 ± 2 °C all three beer-filled kegs showed visible deformations, there was, however, no loss in tightness.

Due to the high temperature and the contemporaneously increased internal pressure the material of the container is exposed to higher temperature strain than usual. The test has revealed that even under extreme conditions during transport or stocking the test containers don’t lose their tightness. Strain rate or, respectively, the deformations of the containers demonstrate that such conditions should be avoided.

4.5 Microbiological Test

The microbiological test of empty test containers revealed no microorganism colonies, either on the Wort-agar or on the S7-S-Agar the bio-burden amounted to 0 colonies / ml (26 °C). The filtrated volume amounted to 500 ml each.

The microbiological test revealed no hint to possible microbiological contaminations of the empty containers.

4.6 Permeation behaviour / Barrier properties

4.6.1 O_2-uptake

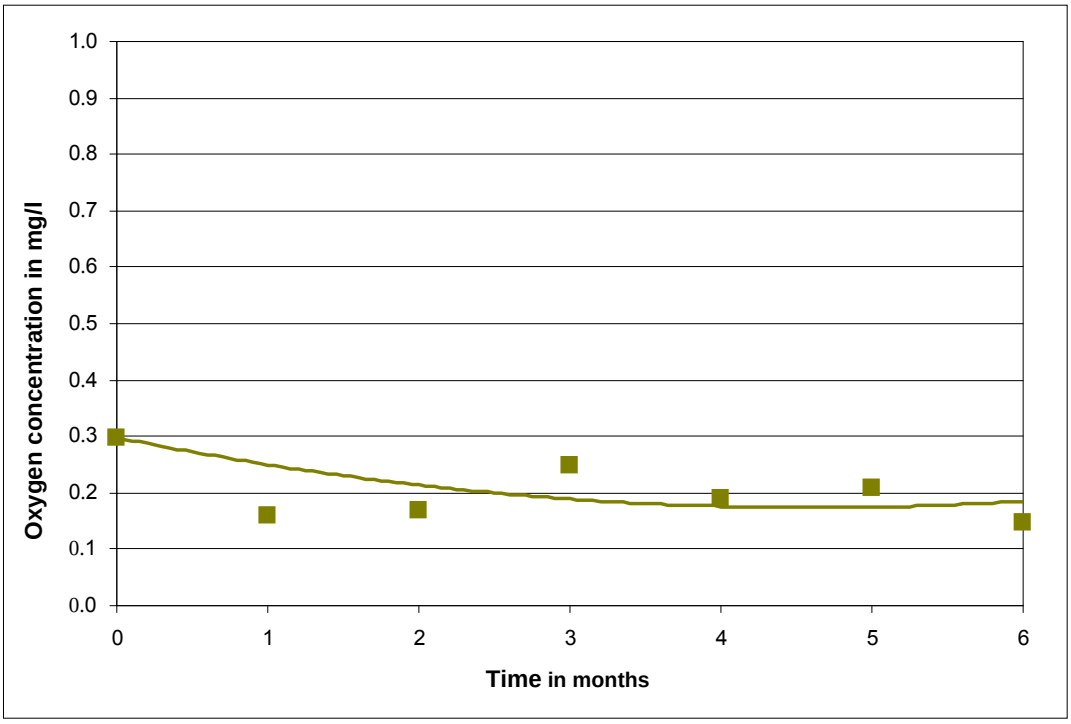

Image 9: Oxygen take-up within a 6 months period at a temperature of 21 ± 2°C

At the beginning of the test series the oxygen content amounted to 0.3 mg/l. During the stocking period of 6 months the oxygen content within the container dropped slightly and remained at a level of approximately 0.2 mg/l till the end of the test.

During the whole stocking period the container, respectively the O_2-Scavenger (oxygen carrying additive) that was integrated in the container jacket, prevented additional oxygen from penetrating the container. Furthermore it was even possible to extract oxygen from the medium (vented and carbonised water).

The container is suited to protect its content over a period of at least 6 months against the penetration of atmospheric oxygen. This characteristic is particularly important with oxygen sensitive beverages such as beer.

4.6.2 CO_2-loss

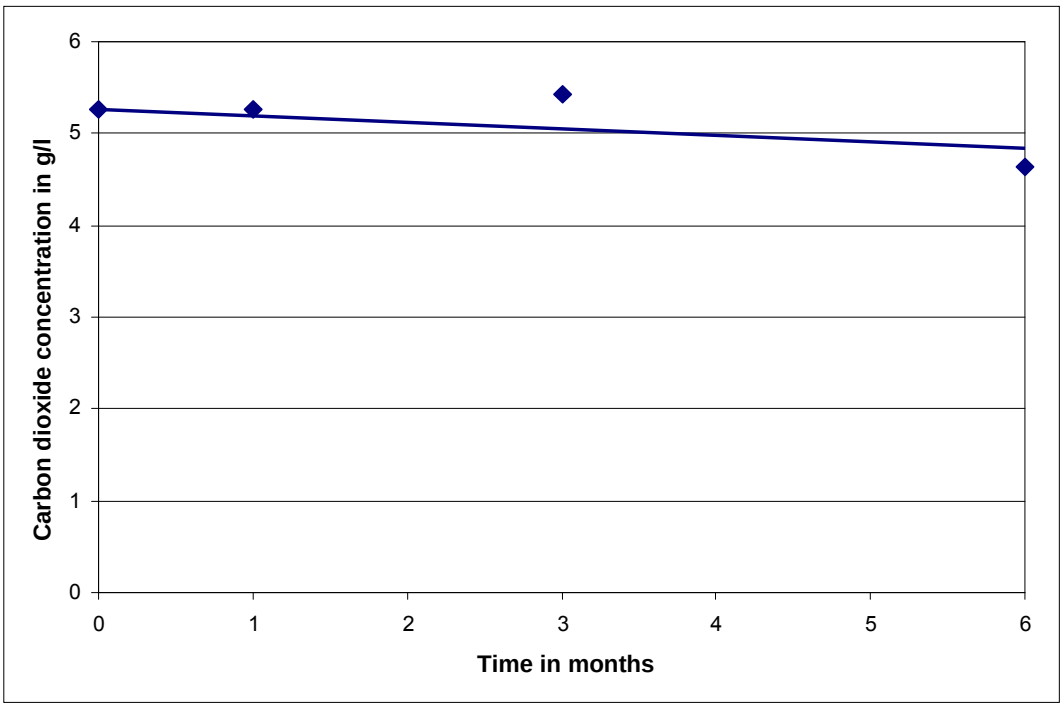

Image 10: Progress of the carbon dioxide content within a 6 months period and a temperature of 21 ± 2°C

The test on the starting value of the CO_2-content on containers filled with beer showed, immediately after the arrival of the containers, a value of 5.27 g/l. During the first three months of the stocking period this no modifications of this value could be registered. After 6 months the test on the CO_2-content resulted in a value of 4.65 g/l. This means that there has been a CO_2-loss of 12 % and thus less than 15 %, usually the highest acceptable CO_2-loss rate for beer in plastic containers. Concerning the CO_2-loss the tested containers are suitable to stock beer for a period of at least 6 months.

4.6.3 CO_2-loss with stocking at increased temperature

CO_2-content (Starting value):	5.27 g/l
CO_2-content (7 warm days at 30 °C):	5.21 g/l

After a stocking period of 7 days at temperature of 30 ± 1 °C three containers filled with beer were tested for their CO_2-content. The tests revealed an average CO_2-content of 5.21 g/l. The value corresponds with the starting value of 5.27 g/l.

Therefore there was no CO_2-loss during a stocking period of 7 days at a temperature of 30 ± 1 °C.

5 Summary

In the context of a commissioned analysis for the KHS GmbH at the test centre for packaging at the Forschungsinstitut für Maschinen- und Verpackungstechnik (FMV) der Versuchs- und Lehranstalt für Brauerei in Berlin (VLB) e.V. (Research Institute for Plant Equipment and Packaging Technology (FMV) of the Research and Teaching Institute for Brewing in Berlin (VLB) e.V.) we carried out tests on the Petainer Kegs™ of the manufacturer Petainer UK Holdings Ltd. The containers in question are PET-containers that can be used as an alternative to high-grade steel kegs. Petainer Kegs™ are available with a capacity of 20 litres and in the near future with a capacity of 30 litres. The tests were carried out on the 20 litres kegs.

The tests included examinations of filling volume, volume consistency, tightness at high temperatures, mechanical stability as well as on the microbiology of the containers. In addition the containers were checked for their barrier properties concerning permeation of inorganic gasses. The objective of the tests was to check the suitability of the containers for stocking of beer over a period of at least 6 months.

The tests showed that the thin-walled containers, despite their light weight, meet all basic mechanical requirements. The barrier properties concerning the oxygen uptake and the loss of carbon dioxide within the beverage meet all requirements for the stocking of beer over a period of at least 6 months. Also from a microbiological point of view the containers were up to all requirements.

To sum up: The Petainer Kegs™ are suitable for the filling with beer or similar CO_2-based beverages and stocking over periods of at least 6 months. Even the increase of the stocking temperature to 30 °C over a period of 7 days showed no negative impact on the packaging.

Sincerely yours

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