ALLPLAS Floating Balls

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RITTER CHEMIE

RITTER CHEMIE

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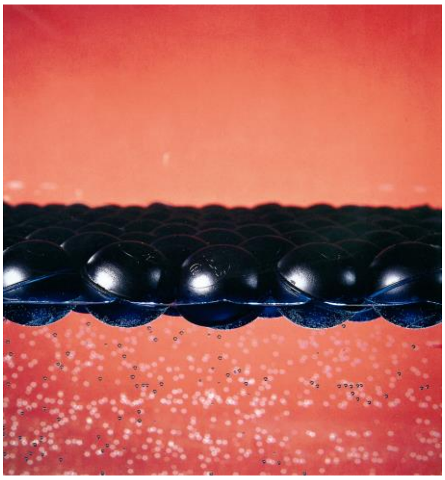
History of ALLPLAS-Floating Balls

In September 1963 the company RITTER CHEMIE was founded in Bremen.
Besides of producing products for surface treatment RITTER is additionally manufacturing hollow plastic balls in various diameters.



These balls are successfully applicable in all kinds of industrial and private branches, for example

- as blanket system for different liquids
- for marking the water level in hydro-culture etc.
- for filling (litre out) airbags
- as valve stopper
- for cleaning (washing) of waste gas
- for fish cultivation

ALLPLAS-floating balls always flexibly cover approximately 90 % of a liquid surface. They also avoid evaporation and fast temperature losses on liquid surfaces and eliminate as well unhealthy and toxy, merely annoying air and corrosive smells up to 99 %.
ALLPLAS-floating balls are resistant to most of acids, caustic solutions, solvents and mineral oils.

The balls are moulded with an ***anti-rotation collar*** to give them a higher stability and to hinder them to rotate. This is so important for an effective reduction of surface increases which means evaporations.

ALLPLAS-floating balls are available in diameters of 7,5 mm up to 150 mm, of different materials and different colours. They are resistant to temperatures up to +140°C. Some executions are also available UV-stabilized and conductive. All balls can also be supplied with a smooth surface, i.e. without collar.

The history of **ALLPLAS-balls** started about 50 years ago in Great Britain when the problem of covering chrome baths had to be solved. Due to high temperatures only heavy-duty-balls with a diameter of 45 mm were applicable. At that time the patent for using balls on chrome baths had been in the hands of Messrs. Schering, but expired about 35 years ago.

The manager of RITTER's agency, Messrs. Capricorn, in Great Britain invested a lot of energy and time to introduce the balls to a wide public. He wrote and published quite a number of special articles for industrial newspapers, magazines etc. with a surprising success.
Via Great Britain those „*tiny balls*" went on their trip around the world. Many countries obtained licenses. Also New Zealand where smart people discovered that **ALLPLAS-balls** are a low-price, easy handling and long-living blanket system for liquids.
During the oil depression at the beginning of the 1970 the **ALLPLAS balls** had their renaissance in Germany. Everybody was forced to save energy, but on the other hand did not want to invest a lot of money, as everybody had the opinion that this depression was only a temporary affair! This crisis ended, the balls had convinced their users and stayed at the places where they have been needed. But the idea of saving – not only energy – had a positive influence, especially in connection with today's global environmental problems and careful handling of our ressources, where **ALLPLAS balls** have proved their efficiency.
In the meantime well-known companies such as BASF, Bayer, Preussag, Raschig etc. are using **ALLPLAS balls** in their production.
ALLPLAS floating balls did not change their look and effectiveness since more than 50 years – a prove that they are timeless and needed!

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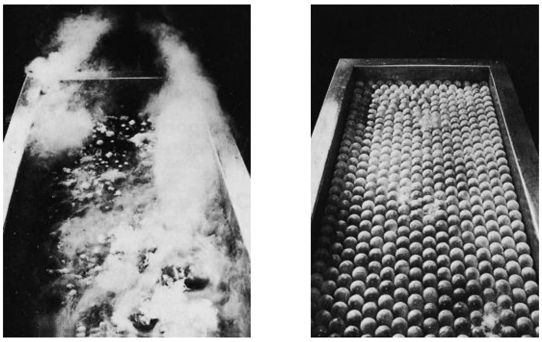
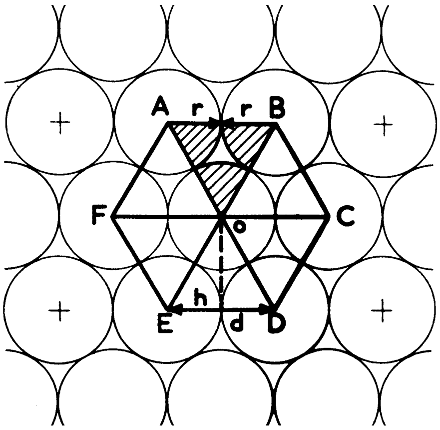


An uncovered metal cleaning tank (left) emits large volumes of corrosive acid steam.
A single layer of ALLPLAS on the surface of the same tank (right), at the same temperature, virtually eliminates acid steam emission.

1. ALLPLAS System

The ALLPLAS system relies on the use of hollow plastic spheres to form a floating blanket cover on the surface of liquid. There are no costs for installation as they automaticllay arrange themselves into a closely packed configuration. All liquids are being covered in that way by nearly 100 % without having the disadvantage of a stabil covering. This system eliminates the danger of building explosives by gas concentrations between liquid surface and cover. The blanket permits free access to the tanks' contents while the complicated handling of solid-installed covers is most likely only possible by using technical support, causes time and overheads as well as costs for personnel. The blanket also allows the diving and removal of all objects at any time.
Regardless of ball diameter, a closely packed arrangement of spheres will always cover approx. 91 % of the surface on which it floats.



Regardless of ball diameter, a closely packed arrange-ment of spheres will always cover approx. 91% of the surface on which it floats.

The diagram shows how the balls arrange themselves automatically. An equilateral triangle can be drawn connecting the centres of three adjacent balls. Since the pattern is symmetrical and repetitive, the triangle and three balls can represent the surface as a whole. The triangle covers one-sixth of each of the three balls, or one-half the area of a single ball. Each leg of the triangle is equal to one ball diameter. The ratio of the area covered by the balls to that enclosed within the triangle is independent of ball diameter, so the total surface covered will always be the same, 91%, no matter what size ball is chosen.
Above the remaining 9 % uncovered surface (intermediate space between balls) pads are coming up with saturated steam which in addition also prevent an evaporation of liquids. The main advantages of the ALLPLAS system are the following:

- ► **Heat losses** will be avoided through one layer of ALLPLAS balls up to approximately 69 % (a double layer reduces loss to 75 % and a triple layer nearly 100 %).
- ► **Energy costs** are being cut extremely, the consumption of expensive chemicals drops sharply.
  Evaporation losses are being reduced up to 88 %.
  With respect to **cooling processes** savings can be achieved through the isolating influence.
- ► **Environmental relieve**, improvement of working conditions and safetyness
- ► **Reduction of smells** (for example reduction of hydrogen sulphide, H_2S,concentrations under defined conditions up to 98,2 %)
- ► **Reduced oxygen absorption** and pollution of liquids
- ► **Avoiding the splashing** of hot and corrosive liquids
- ► **Moisture absorption** from the air is reduced
- ► **Reduced corrosion** problems by construction parts being near-by, as aggressive fumes develop less strongly.

The **cooling** and **freezing** of liquids is retarding.

The financial expenses for the ALLPLAS system are extremly low as the balls do not need any servicing. The balls are simply poured onto the surface of the liquid until it is covered. If the tank has to be cleaned or the balls have to be taken away by any other reason this can be done by a net or basket for example.
In most cases one layer of balls is sufficient while much more improvement of the covering can be achieved by two or more layers.

2. ALLPLAS Floating Balls

They are being used in all kinds of application where liquids have to be protected to avoid evaporation and resulting sequences.
The balls are being produced in a special process so that no seams or blowing holes occur. The ALLPLAS balls are moulded with an **anti-rotation collar**. This unique feature locks the balls in place and prevents natural or forced convection currents from turning the wet sides of the balls to the air (if the sphere were allowed to freely rotate they would act as evaporators). This is important in order to really achieve a reduction of surface increases and resulting evaporations.
For special applications all ball diameters can also be supplied without collar.

3. Applications

In more than 40 years of industrial experience ALLPLAS balls are well approved in all different kinds of industrial application. They are being used where liquids have to be protected by coverage. In addition there are much more application fields.

Below there are some typical application possibilities:

Metal Industry
- Electroplating Plants
- Metal Pre-Treatment
- Metal Refining

Chemical and Plastic Industry
- Chemical and Surface Coating Industry
- Wet Scrubbing Towers
- Pharmaceutical and Cosmetic Industry

Food Industry
- Food Production
- Beer, Wine, Alcohol and Soft Drinks Production
- Storage of Wine
- Fish Farming

Power Plants
- Electricity, Nuclear and Gasplants
- Boiler Houses, Hot Well Insulation
- Cryogenic Plants

Transportation
- Shipsalvage and Buoyancy Aids

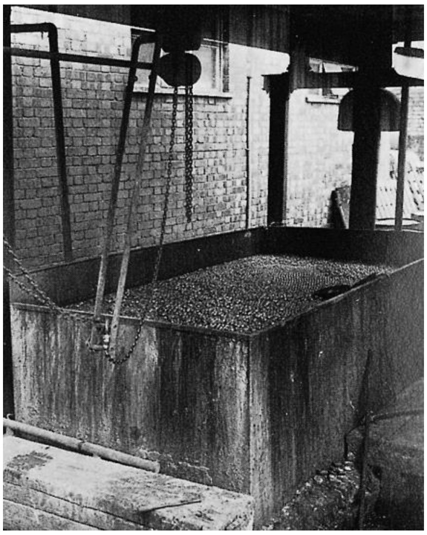
Other Applications
- Sewage and Compost Plants to avoid smell
  Power Plants
- Textile/Paper Industry
- Phototechnical Units
- Laboratories
- Swimming Pools
- Fresh water ponds (to avoid evaporation
- Freezing Protection of all kinds of surfaces

- Battery Production
- Electrical Storage Heaters
- Liquid Level Indicators (for example hydroculture pot plants)

3.1 Energy Conservation

When an ALLPLAS floating ball blanket is installed on the surface of a heated tank, there is an immediate and significant reduction in the amount of energy required to maintain the tank at a constant temperature. Result will vary from case to case, but the fact that ALLPLAS sharply cuts energy requirements – and therefore fuel costs – have been repeatedly confirmed by laboratory tests and industrial evaluations.

An uncovered cleaning tank in a printing ink plant. At. 75-80°C (167-176°F), the dense steam clouds signify high energy losses.



A single layer of 20 mm ALLPLAS balls on the same tank, at the same temperature, stopped steam emission entirely. Not only were energy costs significantly reduced, but working conditions were markedly improved.

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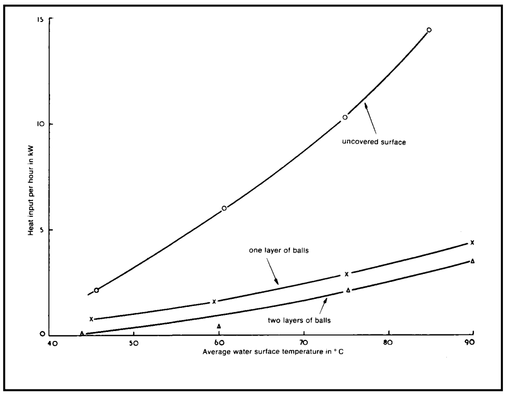
The British National Engineering Laboratory (NEL), for example, took precise measurements on the energy input required to maintain a rectangular tank of water, 1.80 x 1.20 m (5.91 x 3.94 ft) at a series of temperatures from 40° to 90°C (104° to 194°F).

The sides and bottom of the tank were insulated with styrofoam. Heat input was measured when the tank was uncovered, and when it was covered with one and two layers of ALLPLAS balls. The results, as shown in the figure, indicated that at 90°C (194° F), one layer of ALLPLAS balls reduced heat input requirements from 14.4 to 4.3 kwh, or 69.5 %

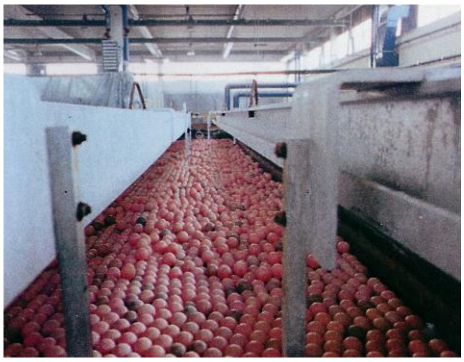


A second layer of balls increased the energy savings to 75,5%. The savings obtained are strongly influenced by temperature, as the figure show: the higher the temperature, the greater the degree of energy conservation.
It must be emphasized that these test conditions do not necessarily represent situations normally encountered in industrial practise. Industrial tanks may not be fully insulated, and in many instances may be exposed to air currents from ventilation systems or open shop doors. In many such cases, substantial quantities of heat are „exported“ from the tanks through the continued dipping and removal of cold components. All these factors considered, the minimum energy savings produced by an ALLPLAS ball blanket usually exceed 50 %.

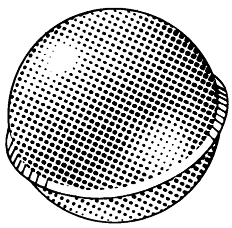
Sometimes, however, plant conditions are such that the energy conservation will be greater than those found in the laboratory.

An electric utility found this to be the case during an „energy audit“ of one of its customers‘ plants. The customer used ALLPLAS ball blankets on some, but not all, of his hot water process tanks. The tanks measure 71 x 671 cm (28 x 264 in) and are held at 99°C (210°F). Air velocity at the tank surfaces is 2.1 m/min (7ft/min), at 18°C (65°F) and 50 % relative humidity.

Under these conditions, the uncovered tanks required a heat input of 166,685 BTU/hr while the ALLPLAS-covered tanks needed only 24,573 BTU/hr, a saving of 85 % in direct fuel costs alone. Additional cost reduction could be achieved through the adoption of changes in heating and ventilation controls, made possible only through the use of the ball blankets, and these will be described in greater detail later.



Metal Refining Industry – Electroplating
nickel/chrome anodising aluminium
Galvanising steel mills copper refining effluents



3.2 Reduced Evaporation Losses

ALLPLAS floating ball blankets are a remarkably effective barrier against the loss of process solutions through evaporation. Many industrial companies report that they have no losses at all.

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The different kinds of vapours can occur – toxic, corrosive, explosive and bad odour.

When using ALLPLAS floating balls there are

- cost savings by using less chemicals
- less services like bath analysis, longer survey intervals (lower personnel costs)
- improvement of expenditure of work, for example the laborious handling of stationary blankets, which often is only possible by means of technical support, is no longer applicable (time saving, reduced overheads) optimum use of liquids which is nearly impossible without blanket by technical reasons

The NEL study described before, in fact, determined that

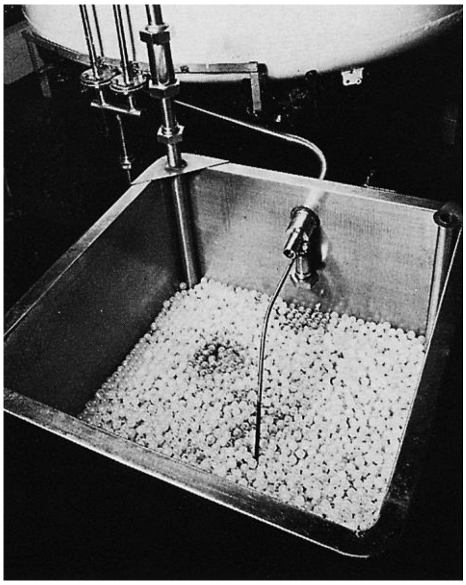
- at 80°C (176°F) an uncovered water surface will lose 2.3 kg/m²h ,
- but one covered with a single layer of ALLPLAS balls will lose only 0.27 kg/m²h, an 88,3% reduction in evaporation rate.

A large missile and aerospace company took advantage of the ability of ALLPLAS to control evaporation during a protracted drought, when water supplies were sharply reduced. By installing floating ball blankets on chromic acid and hot water rinse tanks, the company was able to cut evaporative water losses by up to 75 %.

ALLPLAS ball blankets cut evaporation losses by up to 75 % in anodizing rinse tanks used to treat missile components in an important US-Company. The balls help maintain near-boiling temperatures and keep plant humidity low.

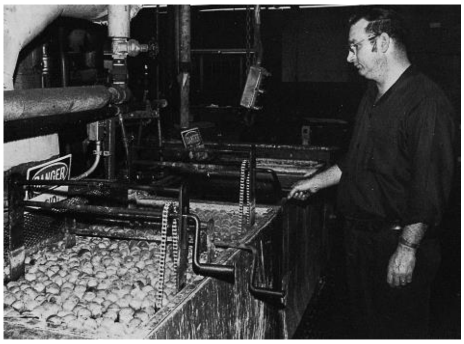
Additional benefits were realized through the reduced load on the exhaust system and lower humidity in the vicinity of precision machining equipment. These spinoffs can be taken as typical, since reduced evaporation usually entails such added advantages as a reduction in the consumption of process chemicals, less variation in process solutions, reduced need for chemical analysis and lower maintenance costs. Because many of these benefits are so important in their own right, they will be discussed in subsequent sections.

Further, the suitability of ALLPLAS balls for use in foodstuffs is borne out by the fact that Scottish whisky distillers have adopted the ball blankets to prevent loss of alcohol (and thus a drop in proof value) during bottling. The application follows more than two years of careful testing, during which it was established beyond any doubt that ALLPLAS does not affect the bouquet of the whisky in any way.



When transferring Scotch whisky through open tanks from large storage vats, evaporation of alcohol led to a reduction in proof. A few layers of ALLPLAS balls solved the problem, and with absolutely no harmful effect on the taste or quality of the product.

3.3 Improved Working Conditions



Balls reduce evaporative energy losses and improve working conditions near a hot phosphating tank used to treat precision machine screws. Although crusted with phosphates, the balls were still giving satisfactory performance after more than two years.

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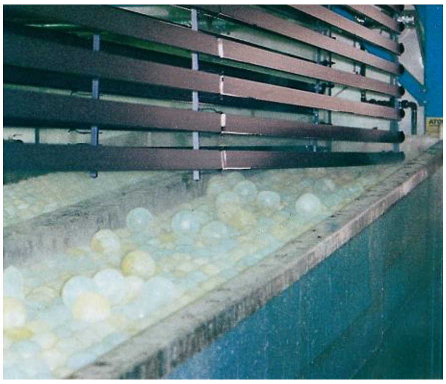
The use of ALLPLAS ball blankets on heated tanks creates a more comfortable and a **safer** in-plant environment. Improved **visibility** is an obvious example.

This can be especially important when tanks must be loaded from above with an overhead crane. In several reported cases, ALLPLAS ball blankets were installed for just this reason, with remarkable success. Worker comfort obviously improves when steam clouds and high humidity conditions are eliminated.

If the vapors in question contain toxic or harmful chemicals, the installation of an ALLPLAS blanket will sharply reduce the incidence of absenteeism due to respiratory illnesses, skin irritations, allergic reactions, and the like. The need for government-mandated safety clothing or equipment, such as face masks, will be reduced and may often be eliminated entirely. Threshold limiting values (TLVs) for hazardous airborne substances can in many cases be maintained, usually without having to resort to additional exhaust systems. Also, employees frequently see the installation of ALLPLAS as a tangible effort to improve working conditions, and higher worker moral inevitably leads to a noticeable increase in productivity.



3.4 Reduced Corrosion Problemes

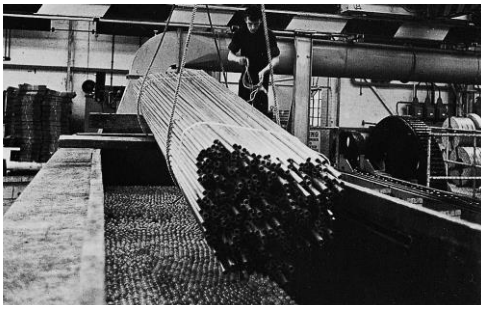
(Reduced Overheads)

The reduction of evaporation from open process tanks has an important bearing on plant operating expense (overheads). Not the least of these are the main-tenance costs due to corrosion damage from chemical or acid vapors. It follows that when the generation of acid steam is eliminated, or nearly so, the need for cleaning and painting will drop, and the service life of electrical and mechanical equipment will improve.

In fact, the expenses of protecting and maintaining equipment and structures located near open process tanks should actually be considered as part of the operating expense of the tanks themselves.

Not only is this seldom done, but the extent of such added costs is frequently not even known. Cleaning and painting are surely expensive, but their cost rises even higher when tanks must be shut down and processes interrupted in order to provide safe access for maintenance crews.

Of course, there is always a temptation to reduce costs by postponing maintenance, but expenses saved in this fashion have a way of reappearing – with interest – in the long term.



ALLPLAS balls covering a hot processing tank in an aluminium plant. The floating ball blanket ensures that surrounding machinery and equipment remain in perfect and fully operational condition.

The installation of an ALLPLAS ball blanket, is a valid and direct way to reduce maintenance costs, because the blankets reduce the need for added cleaning, painting and protective devices.
One user reported that he had learned this fact the hard way: a crane had inadvertently been left overnight over a tank of hot sulphuric acid from which the ALLPLAS ball blanket had been removed.

Despite the fact that the crane had been specially sealed to protect against corrosion, it took electricians 24 hours to return it to service. No corrosion damage to the crane is now noticeable when the ball blanket is in place.

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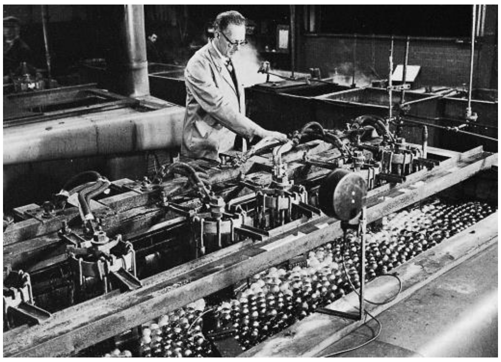
3.5 Galvanising, Electro Plating and Metal Refining

In metal plating applications the generation of hydrogen gas at the electrodes creates problems of both excessive loss of expensive chemicals and furthermore, contamination of the atmosphere with toxic or obnoxious chemicals. The use of ALLPLAS blankets in these applications therefore not only substantially reduce energy requirements but is a major contribution towards improved working conditions and the loss of expensive chemicals. In **hard chromium plating** applications chemical loss through misting has been reduced by up to 85%.



In this chromium-plating installation, ALLPLAS balls so effectively reduced energy and reagent costs that they paid for themselves in only five weeks.

ALLPLAS blankets are widely used in electroliytic metal refining plants and particularly in copper refining where acid misting problems are avoided.

3.6 Reduced Exhaust and Ventilation Requirements

Because the use of an ALLPLAS blanket so sharply reduces the heat and humidity load on an enclosed structure, the capacity of the plant's ventilation system can be considerably reduced. In some cases, the exhaust system can be eliminated entirely.

This reduces both nonproductive power consumption as well as the maintenance expenses associated with fans, motors and ductwork. The savings are frequently compounded by the fact that lower exhaust rates mean lower in-plant air velocities and these in turn lead to lower evaporation rates, even when ALLPLAS blankets are in place. The loss of heat of an open tank depends on an air flow above the tank.

A typical example: Approximately 6,45 kWh/m² are required to keep the temperature of 90°C on a well-isolated tank, if no air flow exists on top of the tank. A considerable increase of heat is necessary if an air flow is existing above the tank. Single results can be taken from the diagram below:

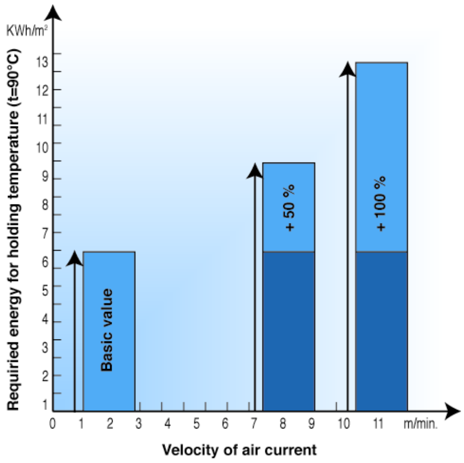


Diagram of energy requirements (at t=90°C) in dependence of air velocity on water surfaces

3.7 Reduced Moisture Absorption

Some liquids absorb moisture from the atmosphere, and the resulting change in solution concentration can have disastrous consequences. For exemple, concentrated sulphuric acid will readily take on atmospheric moisture, and its corrosiveness toward certain materials will actually **increase** as the acid becomes more dilute.

ALLPLAS balls shaprly reduce acid mist generation in this large copper refinery. In-plant atmospheres therefore meet strict health and safety requirements.

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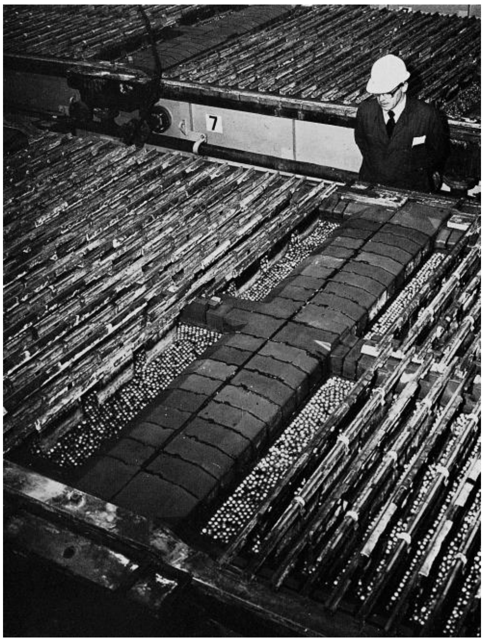
A lead tank, or one constructed of austenitic stainless steel , is quite resistant to attack by concentrated sulphuric acid, but will begin to corrode rapidly as the acid absorbs water from the air.

In large electrolytic copper refineries, where thousands of litres of sulphuric acid are used daily, this atmospherically induced corrosion of the huge acid storage tanks presented a serious problem.

However, tests showed that a single layer of ALLPLAS balls reduces moistrure absorption from the atmosphere by 60%. Therefore, the floating blanket must be thought of as a two-way barrier, reducing mass transfer both into and out of the process fluid on which it rests.

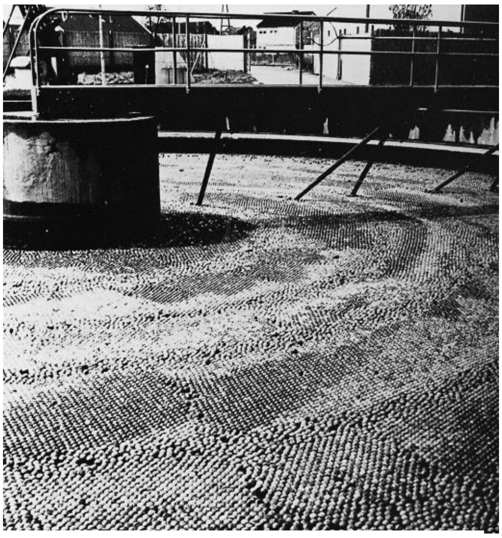


ALLPLAS ball blankets reduce moisture absorption by sulphuric acid solutions. Conversely, reduced acid mist generation cuts plant maintenance costs while improving working conditions.

3.8 Reduction of Smells

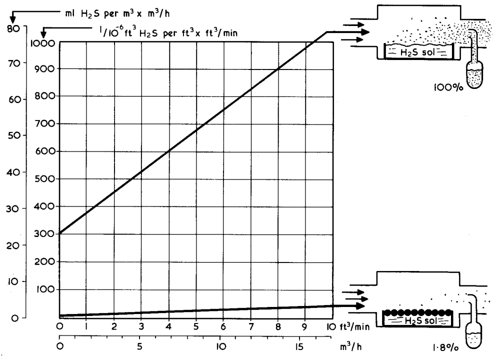
Along with the ability of ALLPLAS to virtually eliminate evaporation and fuming comes a sharp reduction in the emanation of annoying or unpleasant smells.

Of course, this property is less easy to quantify, inasmuch as the ability to perceive smells varies from individual to individual.

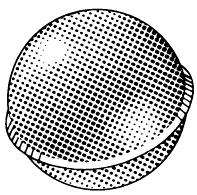


A layer of ALLPLAS balls covers a settling tank at a sewage treatment plant in Germany. Note that the balls automatically rearrange themselves around the moving support members of the sweeper arm. A single layer of ALLPLAS balls reduced odour generation at far less costs than conventional solid covers, yet satisfied the air quality demands of nearby residents.

However, it was found that a single layer of ALLPLAS balls reduced the concentration of H_2S (rotten eggs) above a tank containing a hydrogen sulphide solution by 98.2 % (see diagram) and that, with the floating ball blanket in place, H_2S emission was practically unaffected by air velocity.



It was further found that a double layer of balls reduced the atmospheric concentration of the sulphide by 98.65% and a third layer by 98.8%. Practical experience with ammonia, crude oil and even hydrofluoric acid solutions confirms that an ALLPLAS ball blanket is a highly effective means of eliminating smells.



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3.9 Reduced Splashing

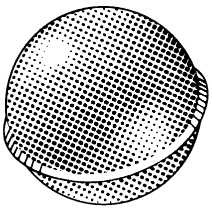
Splashing and spraying of process solutions from open tanks can present a serious safety hazard. Decks and walkways can become slippery and increase the danger of falls and personnel injuries. In the process fluid is hot or corrosive, the danger is even greater, and will likely necessitate the use, as well as the expense and the inconvenience of protective clothing. Obviously, the splashing and misting may also represent a loss of expensive process chemicals.

Besides providing savings in energy and plating chemicals, ALLPLAS balls reduce the danger of splashing and misting, an important safety consideration in manual operations.

However, the simple installation of an ALLPLAS floating ball blanket can significantly mitigate these hazards. This was also born out by tests conducted at Fairey Engineering Ltd., in which spherical weights were dropped into a tank with and without a covering of ALLPLAS balls. It was found that the reduction in the amount of water thrown out varied from

- 86% with the weight falling at 30° to the horizontal onto a single layer of balls up to
- 98% with the weight falling at 90° to the horizontal onto a double layer of balls.

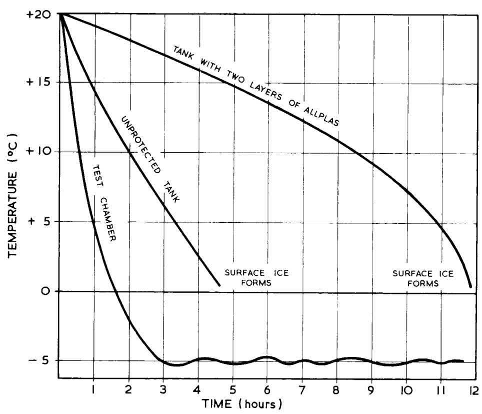
In addition there are electrolytlosses by spray dust, for example for chrome baths up to 30 % of the added chrome acid. These losses can be reduced by application of ALLPLAS balls by approx. 85 %.



3.10 Retarding Temperature Changes

Heat lost to or gained from the atmosphere can be nuisance, even when the power required for heating or cooling is economically insignificant. Gas companies have reported, for example, that a blanket of ALLPLAS balls prevents the water seals surrounding gas holders from freezing overnight, despite several degrees of frost.

While the cost of power used in the past to keep the seals liquid was very modest, the expense of installing and maintaining the special heaters was in some cases considerable. Laboratory tests confirm that under identical conditions, water in an ALLPLAS covered tank takes 300 % longer to freeze than water in an uncovered tank. Even after an ice skin has formed, it thickens much more slowly when the water is covered by a floating ball blanket.



Besides providing savings in energy and plating chemicals, ALLPLAS balls reduce the danger of splashing and misting, an important safety consideration in manual operations.

Similary, ALLPLAS blankets sharply reduce heat losses from heat reservoirs, hot wells, boiler feed and condensate tanks, settling tanks and sumps. Conversely, chilled liquids such as brines used for food processing, heat much more slowly when covered by a layer of ALLPLAS balls.

Of course, the degree to which ALLPLAS will reduce heat transfer across a liquid-gas interface will depend on the specific thermodynamic conditions involved, but both laboratory tests and industrial experience have proved the floating blanket to be an extremely effective thermal barrier.

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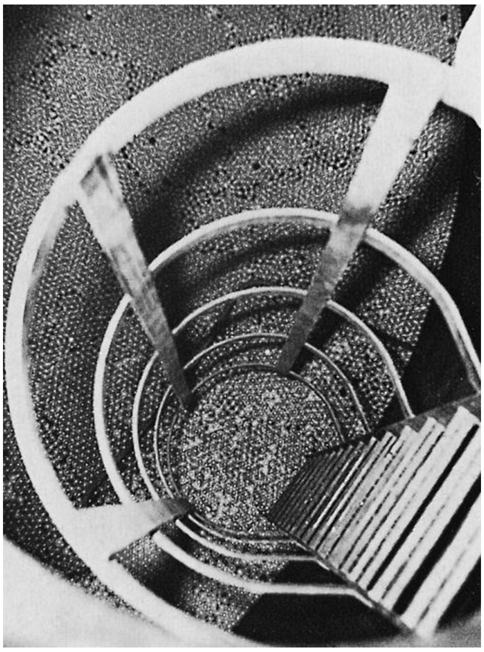
3.11 Reduced Oxygen Absorption

ALLPLAS ball blankets are widely used in **nuclear and conventional power stations** and indeed in many domestic and industrial heating applications where heat losses should be avoided from condensate return tanks or hot wells.

One of six condensate storage tanks at a British nuclear power station. The reactor containment buildings is in the background.



A multi-layer ALLPLAS balls blanket floats on the water surface inside the condensate storage tanks. The balls automatically rearrange themselves around projections such as the ladder and handrail as the water level rises and falls. The balls reduce oxygen absorption by the highly purified water, thereby minimizing corrosion throughout the system.

The main problems with regard to oxygen absorption are found in shut-down periods, and under controlled conditions it has been reported that during a standard shut-down period the dissolved oxygen level, in a hot well, rose by a factor of 42, equally when covered with a single layer of ALLPLAS balls, under identical conditions, the dissolved oxygen level rose by a factor of 2.

A further important benefit in the use of ALLPLAS on **boiler feed applications** is in the ability of a ball blanket to significantly reduce oxygen uptake. High dissolved oxygen levels are largely responsible for excessive corrosion to boilers.

Similarly, the **absorption of oxygen by wine** leads to the loss through oxidation of sulphur dioxide (SO_2), necessary as an antioxidant and for fermentation control.

ALLPLAS balls are used to cover the storage tanks holding quality wines (shown here in a quality control laboratory). The balls reduce oxygen absorption, which otherwise would reduce the free sulphur dioxide content below levels needed for proper fermentation.

Results have shown that such deterioration of wine can be considerably retared by covering the free surface with an ALLPLAS ball blanket, corresponding data please see in the following table:

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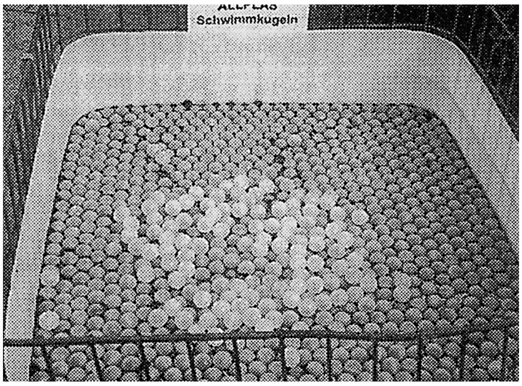
Fall in free SO_2 content, milligrams per litre, due to atmospheric oxidation at temperature of 18°C

Exposure in hours	0	18	42	66	90	234
Layers of balls 0	53	30	18	12 oxid.	12 oxid.	7 oxid.
1	53	42	36	26	22 oxid.	11 oxid.
2	53	47	43	36	32	14 oxid.
3	53	50	46	38	36	18 slightly oxid.



ALLPLAS balls on liquid manure (PP, Ø 38 mm, natural colour), tested by chamber of agriculture Weser-Ems in Oldenburg/Germany.

Black ALLPLAS balls, PP, Ø 70 mm, cover a rectangular tank with sweeper arm containing sewage water of an industrial chemical plant in Germany

Seep tank on a compost plant covered with ALLPLAS balls PP, Ø 70 mm, black.

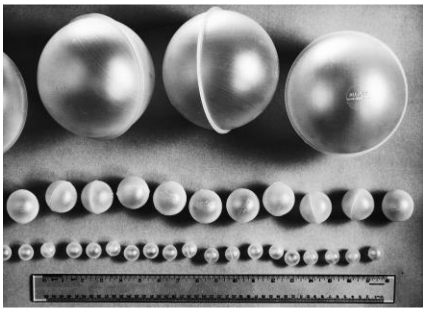
4. Other Applications

In addition to the applications described before, the unique properties of ALLPLAS balls permit them to perform many other duties. Virtually complete elimination of evaporation greatly reduces explosion risk in storage tanks containing fuel or other explosive liquids. Even mildly inflammable liquids burn less violently if ignited, when a layer of ALLPLAS balls reduce the availability of oxygen.

Similarly, the balls can reduce loss of water by Evaporation and algal growth in stagnant pools by restricting oxygenation and shielding sunlight.

Where highly reactive liquids must be protected under a blanket of inert gas, gas consumption can be greatly reduced by filling most of the free tank volume above the liquid with ALLPLAS balls. They can also be used in chemical process plants to increase the gasliquid interface by allowing the liquid to trickle over the balls, entrapped in a cage and held in the gas stream. ALLPLAS balls have been used to cover filter or catalyst beds and thereby prevent bed erosion. They have also been utilized to enlarge liquid surface areas in high-technology distillation columns, and for much the same reason in wet scrubbers.

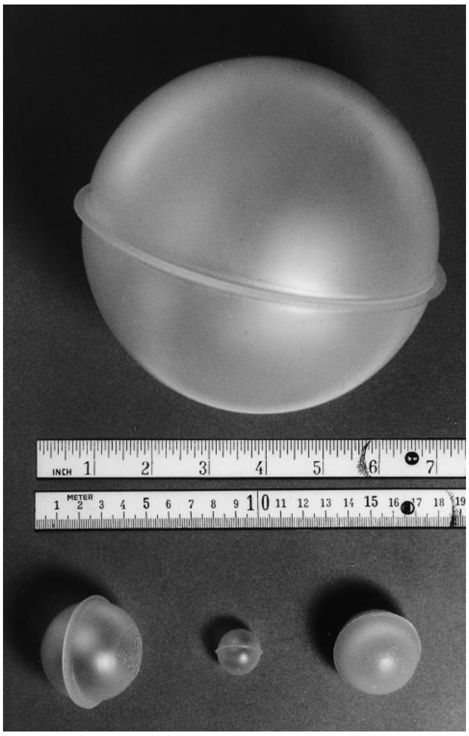
5. ALLPLAS Balls Available Grades and Sizes



ALLPLAS balls are available in PP and PE compositions to suit most laboratory or industrial environments. They are also produced in twelve sizes, as shown in the following table:

PP ø mm	20, 38, 45, 70, 150
PP ø inch	0.75, 1.5, 1.75, 2.75, 6
PE ø mm	7.5, 10, 12, 13.8, 15, 20, 25, 30, 45*
PE ø inch	3/10, 2/5, 0.5, 3/5, 0.75, 1, 1.1/5, 1.75*

* prepared with additives to prevent static charge buildup and black-coloured

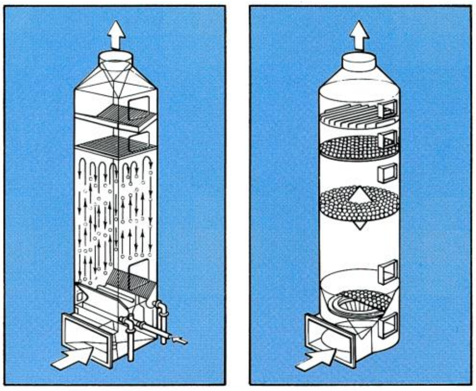


6. Specific Properties Type PP – Polypropylene

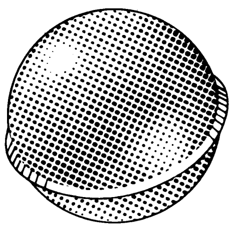
Polypropylene is almost completely chemically inert. Type PP balls are therefore recommended for use with most organic and inorganic solvents, acids, alkalies and mineral oils.

Polypropylene is a colourless, odourless thermoplastic material having high strength and surface hardness. It is the lightest of the commercial thermoplastic polymers.

Type PP balls are suitable for use at temperatures Δ 140°C (285°F).
The **38 mm (1.1/2in) balls** are particularly suitable for long-term use at temperatures above 95°C (203°F).
These balls, with their 2,2 mm (0,087 in) thick walls, are 2,5 to 3 times as heavy as 45 mm balls. This reduces water absorption to a minimum, and makes the balls preferable for use in gas/liquid absorbers, anodizing tanks, settling tanks, carbonate baths as well as all other high temperature baths.
Furthermore 38 mm balls have been used on both oil and salt tempering baths at temperatures up to 140°C (285°F) without deterioration for more than 6 months.
For constant exposure to ultraviolet radiation, 45 mm type PP balls are available as ALLPLAS type PP black. The addition of a black pigment reduces the UV sensitivity of the polypropylene.



Gas washer is covered with ALLPLAS Floating balls of polyethylene - high density, dia. 38 mm



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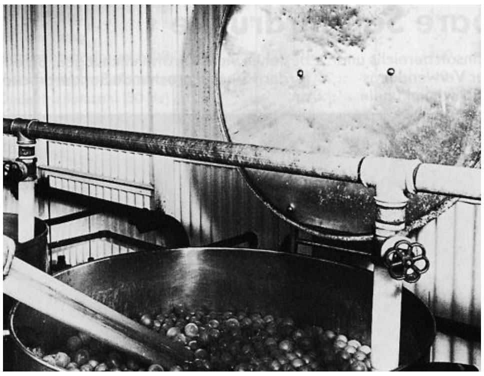
Type PE - Polyethylene

PE balls with diameters of 7.5-30 mm are manufactured from LDPE. These balls are mainly used as liquid level indicators (e.g. filling marks on storage tanks, water level indicators in hydroculture pot plants).

In addition to virtually the same chemical resistance as type PP balls, this type is also resistant to benzene, benzol, petrol and their solutions. The material of the diameter 45 mm balls has been rendered electrically conductive in order to prevent static charge buildup. This type PE-BB balls is black in colour and has a surface resistance $< 10^9$Ohm. They are particularly suited for reducing evaporation from tanks containing aromatic hydrocarbons or petroleum.

7. Toxicological Properties

The PP balls are internationally approved for use with foodstuffs, beverages, medicines and pharmaceuticals, and are also acceptable for the production of household and industrial chemicals.



ALLPLAS balls reduce steam emission and help conserve energy in this syrup plant.

8. Technical Installations

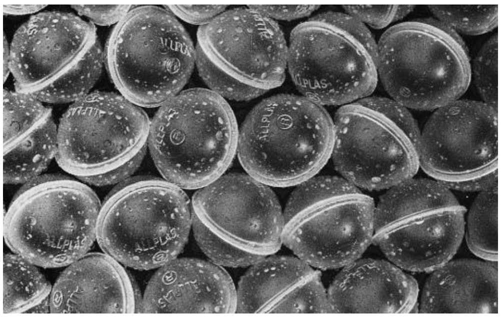
In the vast majority of applications, plant modifications are not required. The ALLPLAS balls are merely dumped on the liquid surface, after which they rapidly arrange themselves into a regularly formed cover. Being a „particulate“ cover the ALLPLAS blanket will adjust itself around obstacles in the tank, such as levels and controls, and will not be affected by changes in liquid level.

As a precautionary measure it is however strongly recommended that all drain holes, overflows and pump inlets are covered by simple wire cages to prevent blockage or entry of the balls into the pumping system.

In metal pre-treatment or dip treatment applications the problem of entrappment of balls within the components during withdrawal from the processing tanks can, in most cases, be overcome by selection of the correct size

ALLPLAS balls. Where, however, this is not possible, components may be dipped or withdrawn through part of the liquid surface which has been previously freed by utilising a simple paddle or sweeper arrangement.

Balls can be prevented from entering baskets by covering these with a canted and easily removable cover. In some cases a net, normally allowed to sink to the bottom of the tank, is used to remove all balls from the surface in a matter of seconds simply by lifting the net out together with the balls.



9. Available Literature

The wide ranging and sometimes unorthodox uses which ALLPLAS balls have been put to are described in numerous publications. Reprint copies are available on request.

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Mechanical, Thermal and Electrical Properties

RITTER CHEMIE

Property	Unit	PP Value	PE-BB Value
Colour	–	Milky White	Black
Density	g/cm^3	0.904	0.985
Operating temperature	°C (°F)	120 (250) max.	60 (140) max.
Coefficient of linear expansion, 20° C(68° F)	$°C^{-1}$	1.5×10^{-4}	–
Coefficient of volumetric expansion, 20° C (68° F)	$°C^{-1}$	4.5×10^{-4}	–
Melting range (polarizing microscope)	°C (°F)	158–164 (316–327)	–
Charpy Impact Strength			
20° C (68° F)	mJ/mm^2	no fracture	–
0° C (32° F)	"	no fracture	–
–20° C (–4° F)	"	70	–
Bending limit stress per DIN 53452	N/mm^2	46	–
Tensile strength	N/mm^2	44	15
Elongation	%	750	> 600
Elastic modulus per DIN 53457	N/mm^2	1400	–
Vicat softening point	°C	140	–
Relative permittivity	–	2.3	–
Specific heat (solid), 20° C (68° F)	J/gK	1.92	–
Thermal conductivity	W/mK	1.4651×10^{-1}	–
Surface resistance	Ohm	$> 10^{13}$	$< 10^{9}$
Hardness per DIN 53456	N/mm^2	64	50

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Volumetric Properties

RITTER CHEMIE

	PP					
	Ø 20 mm (3/4 in)	Ø 38 mm (1 1/2 in)	Ø 45 mm (1 3/4 in)	Ø 45 mm/6 (1 3/4 in)	Ø 70 mm (2 3/4 in)	Ø 150 mm (6 in)
Weight (g) (oz)	0.9 0.033	10–11 0.353–0.388	5 0.18	6–6.5 0.22–0.23	17 0.62	87 3.07
Volume (cm^3) (in^3)	4.187 0.221	28.72 1.75	47.69 2.807	47.69 2.807	179.5 10.57	1767 113.2
Surface Area (cm^2) (in^2)	12.56 1.768	45.34 7.03	63.59 9.620	63.59 9.620	154 23.7	706.5 113.1
Wall Thickness (mm) (in)	0.55 0.022	2.2 0.087	0.5 0.02	1 0.04	1 0.04	1.04 0.041

	PE								PE-BB
	Ø 7.5 mm (3/10 in)	Ø 10 mm (2/5 in)	Ø 12 mm (1/2 in)	Ø 13.8 mm (1/2 in)	Ø 15 mm (3/5 in)	Ø 20 mm (3/4 in)	Ø 25 mm (1 in)	Ø 30 mm (1 1/5 in)	Ø 45 mm (1 3/4 in)
Weight (g) (oz)	0.08 0.003	0.2 0.007	0.3 0.01	0.25 0.009	0.35 0.01	0.9 0.03	1.2 0.04	1.5 0.05	5.4 0.2
Volume (cm^3) (in^3)	0.22 0.01	0.52 0.03	0.9 0.05	1.4 0.08	1.8 0.11	4.2 0.25	8.2 0.49	14.1 0.86	47.7 2.8
Surface Area (cm^2) (in^3)	1.8 0.3	3.1 0.5	4.5 0.7	6.0 0.9	7.1 1.1	12.6 2.0	19.6 3.0	28.3 4.4	63.6 9.6
Wall Thickness (mm) (in)	0.3 0.01	0.5 0.02	0.6 0.02	0.5 0.02	0.3 0.01	0.7 0.03	0.5 0.02	0.5 0.02	0.8 0.03

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Ball Requirement per Unit Area and Volume

RITTER CHEMIE

	Ø 7.5 mm (3/10 in)	Ø 10 mm (2/5 in)	Ø 12 mm (1/2 in)	Ø 13.8 mm (1/2 in)	Ø 15 mm (3/5 in)	Ø 20 mm (3/4 in)
Quantity/m^2	18.500	13.000	8.500	5.750	5.000	2.500–3.000
Quantity/ft^2	1.700	1.200	770	520	450	230– 280
Quantity/m^3	2.800.000	1.700.000	650.000	480.000	360.000	165.000–167.000
Quantity/ft^3	78.500	47.000	18.500	13.500	10.100	4.670–4.730

	Ø 25 mm (1 in)	Ø 30 mm (1 1/5 in)	Ø 38 mm (1 1/2 in)	Ø 45 mm (1 3/4 in)	Ø 70 mm (2 3/4 in)	Ø 150 mm (6 in)
Quantity/m^2	1.750	1.250	750–800	500–575	250	45–50
Quantity/ft^2	170	120	75– 85	45– 55	20–25	4–5
Quantity/m^3	75.000	42.000	24.500–25.000	14.500–15.000	3.750	350–400
Quantity/ft^3	2.100	1.200	690–710	410–425	105–110	10–11

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RITTER CHEMIE

Chemical Resistance

1. Oxidation

In the case of continuous outdoor exposure polypropylene has to be protected against UV radiation in the same manner as other polyolefins. UV radiation strongly accelerates the oxidation breakdown at ambient temperatures, and for this reason, ALLPLAS Black balls should be used in installations subjected to direct sunlight. ALLPLAS Black balls contain a fine dispersion of 2% carbon black.

2. Water

The resistance of polypropylene to water is extremely good. Water absorption according to ASTM D570-54T amounts to 0.03% after 24 hours immersion. Polypropylene absorbs less than 0,5% of most surrounding liquids on storage for more than six months at room temperature and less than 2 % during the same period at 60° C (140° F).
Polyethylene balls are suitable for use in destilled water to 60° C (140° F).

3. Inorganic Media

Polypropylene and polyethylene are highly resistant to most inorganic liquids. They are attacked neither by aqueous solutions of most inorganic salts nor by most mineral acids and alkalies, even in concentrated form, and remain very resistant up to 60° C (140° F). These materials are only affected by strong oxidizing reagents. Chlorosulphonic acid, 100% oleum, fuming nitric acid and halogens attack polypropylene and polyethylene at room temperature. Concentrated (98%) sulphuric acid and 30% hydrogen peroxide show little effect on polypropylene at room temperature, while polyethylene is unaffected by 30% hydrogen peroxide at 60° C (140° F).

4. Organic Media

Polypropylene and polyethylene are highly resistant to most organic chemicals. The degree to which the balls will absorb liquids is dependent on temperature and the polarity of the organic medium. In this respect nonpolar liquids such as benzene, carbon tetrachloride and petroleum ether are more strongly absorbed than polar liquids like ethanol and acetone. Service life, beyond the influence of the above factors, is affected by the absorption of light.

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Chemical Resistance-Table

Product	Concentration %	Temperature 20° C (68° F) PP	PE-BB	60° C (140° F) PP	PE-BB	100° C (212° F) PP	PE-BB
Acetic acid	10–60	A	A	A	A	A (80° C, 175° F)	
Acetic acid ethylester		B	A	B	B		
Acetone	technical quality	A	A	B	B		
Acetophenone	100	B		B			
Acronal	commercial		A		B		
Acrylic emulsion	100	A		A			
Acrylonitrile	technical quality		A		A		
Adipic acid	S		A		A		
Alums (all types)		A	A	A	A		
Allyl acetate			A		B		
Allyl alcohol	96		A		A		
Allyl chloride			B		C		
Ammonia gas	100	A	A	A	A		
Ammonia, w	conc.	A		A			
Ammonia, w	10	A		A			
Ammonia-water		A	A		A		
Ammonium acetate	S	A		A		A	
Amm. carbonate	S	A	A	A	A	A	
Amm. chloride	S	A	A	A			
Amm. fluoride	20	A		A			
Amm. nitrate	S	A	A	A	A	A	
Amm. phosphate	S	A	A	A	A	A	
Amm. persulphate	S	A		A			
Amm. sulphate	S	A	A	A	A	A	
Amm. sulphide	S	A	A	A	A		
Amm. thiocyanate		A	A	A	A		
Amino acid			A		A		
Amyl acetate	technical quality	B	A	C	A		
Amyl alcohol	technical quality	A	A	B	A		
Amyl chloride	100	C	B	C	C		
Amyl phthalate			A		B		
Alumin. salts, w	ac	A	A	A	A	A	
Aniline	100	A		A			
Aniline	S	A	A	A	A		
Anisole	100	B		B			
Antimony chloride		A	A	A	A		
Antifreezing solution	commercial	A	A	A	A		
Apple juice		A		A			
Apple wine			A		A		
Aqua regia		A	C	C	C		
Arsenious acid	100		A		A		
Arsenious acid	80		A		A		
Aviation fuel (115/145 octane)	100	B		C			
Barium salt, w	ac	A	A	A	A	A	
Barium hydroxide	ac	A	A	A	A		
Beef suet			A		B		
Beer		A	A	A	A		
Beeswax			A		B		
Benzene	technical quality	B	B	C	B		
Benzoic aldehyde	100	A					

Product	Concentration %	Temperature 20° C (68° F) PP	PE-BB	60° C (140° F) PP	PE-BB	100° C (212° F) PP	PE-BB
Benzaldehyde, w		A	A	B			
Benzine (boiling point 100–140° C = 212–285° F)	100	A	A	A			
Benzoic acid	100	A	A	A			
Benzoyl chloride			B		B		
Benzyl alcohol		A	A	A	A	A (80° C, 175° F)	
Bismuth carbonate	S	A	A	A			
Borax, w	S	A	A	A	A		
Boric acid, w	ac	A	A	A	A		
Boric acid-methylester			A				
Boron trifluoride			A		B		
Bone oil		A	A	A	A		
Brandy			A		A		
Bromine liquid	100	C	C		C		
Bromochloro-methane			C		C		
Bromine water	S	C	A	C			
Butane gas		A	A	A			
Butane liquid	100	A					
Butanediol, w	till 10%		A		A		
Butanol, w	till 100%	A	A	A	A		
Butter-milk		A					
Butyric acid, w	20		A		B		
Butyl acetate		A	A	B	B		
Butylphenol	technical quality		A		A		
Calcium carbonate		A	A	A	A		
Calcium chlorate		A	A	A	A		
Calc. chloride, w	ac	A	A	A	A	A	
Calc. hydroxide		A	A	A	A		
Calc. nitrate	diluted	A	A	A	A		
Calc. phosphate		A	A		A		
Calc. Hypochloride bleach		A	A	A	A		
Caustic soda		A	A	A	A		
Camphor		A	A		B		
Carbolic acid			A		A		
Carbon disulphide		B	B				
Carbon dioxide	100	A	A	A	A		
Carbon monoxide		A		A			
Carbonic acid, wet	ac		A		A		
Carbonic acid, dry	100		A		A		
Carbon tetrachloride	technical quality	B	C	C	C		
Coconut alcohol	technical quality		A		B		
Coconut oil		A	A	A	B		
Cresole	100	A	A	B	B		
Copper salts	S	A	A	A	A	A	
Cetyl alcohol		A	A		A		
Chlorine gas, dry		C	B	C	C	C	
Chlorine gas, wet	10	B	B	C	C	C	
Chlorine, liquid		C	C		C		
Chlorobenzene		C	B	C	C		
Chloroacetic acid, w	85		A		A		
Chloroformates			A		B		
Chloroform	technical quality	B	C	C	C		
Chlorosulphonic acid		C	C	C	C		
Chlorine water, w	S	B	A	C	B		
Cod-liver oil		A	A		B		

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ALLPLAS - APPENDIX II - Chemical Resistance-Table

Product	Concentration %	Temperature 20° C (68° F) PP	PE-BB	60° C (140° F) PP	PE-BB	100° C (212° F) PP	PE-BB
Corn germ oil		A	A	B	B		
Clove oil		A		B			
Citric acid, w	S	A	A	A	A	A	
Chromosulphuric acid		C	A	C	C		
Chromium salts, w (II-, III-valent)	S	A		A			
Chromic acid, w	80	A					
Chromic acid, w	50	A	A	A	C		
Chromic acid, w	10	A	A	A	A		
Coca Cola®		A	A		A		
Crude Oil			A		B		
Cyclohexane		A	A		A		
Cyclohexanol		A	A	A	A		
Cyclohexanone		A	A	C	B		
Deca-hydro-naphthalene	technical quality	B	A	C	B	C	
Decalin	100	B	A	C	B	C	
Dextrin, w	18		A		A		
Dextrose			A		A		
Diethanolamine	100	A		A			
Diethylene glycol			A		A		
Diethyl ketone			A		B		
Dibuthyl ether			B		C		
Dibutyl phthalate	100	A	A	B	B		
Dibutyl sebacate		A	A		B		
Dichlorethylene		A	C		C		
Defoamer			A		A		
Dichloroacetic acid methylester			A		A		
Dichlorodiphenyl trichloroethane (DDT)			A		A		
Diethylether		B	B	B			
Dichloropropane			B		C		
Dichloropropene			B		C		
Diesel-fuel		A	A	B	B		
Diglycol acid, w	30		A		A		
Di-iso-butyl-ketone	technical quality		A		C		
Di-iso-octyl-phthalate	100	A		A			
Di-iso-nonyl-phthalate		A					
Dimethyl amine			A		B		
Dimethyl formamide	technical quality	A	A		B		
Dioctyl adipate		A					
Dioctyl phthalate		A	A		B		
Dioctane	technical quality		A		B		
1,4 Dioxane	100	A				C	
Diphenylamine			A		B		
Developing solutions (photographic)		A	A	A	A		
Emulsifiers		A	A	A	A		
Epichlorohydrin			A		A		
Ester, aliphatic	technical quality		A		B		
Ether		B	B		B		
Ethyl acetate	technical quality	B	A	B	B		
Ethyl alcohol	96	A	A	A	A	A	
Ethyl ether	technical quality	B	B				
Ethyl benzene	technical quality	B	B	C			
Ethyl chloride	technical quality	C	B				
Ethylene chloride		B		B			
Ethylene diamine	technical quality		A		A		

Product	Concentration %	Temperature 20° C (68° F) PP	PE-BB	60° C (140° F) PP	PE-BB	100° C (212° F) PP	PE-BB
Ethylene diamine tetra-acetic acid			A		A		
Ethylene dibromine			B		C		
Ethylene dichloride			B		C		
Ethylene glycol		A	A	A	A		
Ethanol amine	100	A		A			
2-Ethyl hexanol	100	A					
Ethane tetrachloride		B	C	C	C		
Ethylene tetrachloride	100	B		C			
Fatty acid		A	A	A	B		
Fatty alcohol			A		B		
Fatty acid amide			A		B		
Fixing salt	10	A	A	A	A		
Fluorine			C		C		
Fluoro silicic acid	32		A		A		
Formaldehyde, w	40	A	A	A	A		
Formamide			A		A		
Formic acid, w	100	A		B			
Formic acid, w	50	A		A			
Formic acid, w	10	A		A		A	
Freon							
Frigen 12 (Freon 12)	100		B		C		
Fructose		A		A			
Fruit juices	commercial	A	A	A	A		
Furfurol		C	A	C	B		
Fuel Oil		A	A	B	B		
Fuel to DIN 51635		A		B			
Gasoline	100	B		C		C	
Gelatine		A	A	A	A		
Gearbox-oil	100	A		B			
Gin	40	A	A		A		
Glucose, w	S	A	A	A	A		
Glycol	100	A		A			
Glycol, w	commercial	A	A	A	A		
Glycerine, w	ac	A	A	A	A		
Heptane		A	A	B	B		
Hexane		A	A	B	B		
Hydraulic fluids			A		B		
Hydrobromic acid, w	48		A		A		
Hydrofluoric acid	36–40	A	A	A	B		
Hydrofluoric acid	85		A		B		
Hydrogen sulphide, w	conc.		A		A		
Hydrogen sulphide, w	low.	A	A	A	A		
Hydrogen chloride, gas	conc.	A	A	A	A		
Hydrogen peroxide	30	A	A	B	A		
Hydrogen peroxide, w	10	A		A			
Hydrogen peroxide, w	3	A		A		A	
Hydrochloric acid, w	conc.	A	A	A	A		
Hydroquinone		A	A	A	A		
Hypochlorite acid			A		B		
Ink		A	A	A	A		
Iron salts, w	S	A	A	A	A		
Iso-octane	100	A	A	B	B		
Isopropyl alcohol		A	A	A	A		
Isopropyl acetate			A		B		
Isopropyl ether			A		C		

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ALLPLAS - APPENDIX II - Chemical Resistance-Table

Product	Concentration %	Temperature 20° C (68° F)		60° C (140° F)		100° C (212° F)	
		PP	PE-BB	PP	PE-BB	PP	PE-BB
Iodine tincture	commercial	A	A		B		
Jam		A	A	A	A	A	
Ketones		A	B		C		
Lard		A		A		B	
Lanolin		A	A	B	A		
Lactic acid, w	10–96	A	A	A	A		
Lemonades		A					
Lead acetate, w	ac	A	A	A	A		
Linseed oil	technical quality	A	A	A	A		
Liqueurs		A	B		C		
Lubricating oils		A	A	B	B		
Magnesium salts		A	A	A	A	A	
Magnesium hydroxide	S	A	A	A	A		
Manganese sulphates			A		A		
Margarine		A	A	A	A		
Machine oil			A		B		
Mayonnaise		A	A				
Menthol		A	A	A	B		
Methacrylic acid			A		A		
Methanol	technical quality	A	A	A	A		
Methoxybutanol			A		B		
Methyl ethyl ketone	technical quality	A	A	B	C		
Methylene chloride		B	B		B		
Methyl glycol			A		A		
Metal Baths		A	A	A	B		
Lemon juice		A		A			
Lemon peel oil		A					
Mercury		A	A	A	A		
Mercury salts		A	A	A	A		
Milk		A		A		A	
Milk foods		A		A		A	
Mineral Oils (free from aromatics)	without additives	A	A	B	B	C	
Molasses		A		A			
Motor Oils		A	A	B	B		
Mustard		A	A		A		
Nail varnish		A		B			
Nail varnish remover		A	A	B	B		
Naphthalene		A	A		B		
Nickel salts, w	S	A	A	A	A		
Nitro benzene		A	A	A	B		
Nitro cellulose			A				
Nitrous fumes	conc.		A		B		
Nitric acid	25	A	A	A	A		
Olive Oil		A		A			
Oil No. 3 to ASTM D 380–59	100	A		B		C	
Oils, vegetable and animal			A		B		
Oleic acid	conc.	A	A		B		
Oleum	10	C	C	C	C	C	
Orange peel oil		A					
Oxygen	ac		A		A		
Oxalic acid	50	A	A	B	A		
Oxalic acid	S	A		A		A	
Ozone (< 0,5 ppm)		A	B	B	C		
Palm oil		A		B			
Palmitic acid			A		A		

Product	Concentration %	Temperature 20° C (68° F)		60° C (140° F)		100° C (212° F)	
		PP	PE-BB	PP	PE-BB	PP	PE-BB
Paraffin	100	A		A		C	
Paraffin oil		A	A	B	A	C	
Perchlorethylene		B	B	C	C		
Perchloric acid	20		A		A		
Petroleum		A	A	B	B		
Petroleum ether		A	A	B	B		
Peppermint oil		A					
Phenol		A	A	A	A		
Phenyl ethyl alcohol			A		A		
Phenyl sulphonate			A		A		
Phosgene, gas	100		C		C		
Phosphorus pentoxide	100	A	A		A		
Phosphoric acid, w	40	A	A	B	A		
Phthalic acid, w	50		A		A		
Pine oil		A	A	A	B		
Pineapple juice		A	A	A	A		
Polyglycols			A		A		
Petrol, reg.		A		C			
Petrol, prem.		B	A	C	B	C	
Petrol-benzene-mixture	80/20		A		B		
Potassium borate, w	1	A	A	A	A		
Potassium bromate, w	till 10	A	A	A	A		
Potassium bromide, w	S	A	A	A	A		
Potassium carbonate		A	A	A	A		
Potassium chlorate, w	S	A	A	A	A		
Potassium chloride, w	S	A	A	A	A	A	
Potassium chromate	40	A	A	A	A		
Potassium cyanide, w	S	A	A	A	A		
Potassium fluoride		A	A	A	A		
Potassium hexacyanoferrates		A	A	A	A		
Potassium hydroxide		A	A	A	A		
Potassium hydroxide, w	50–60	A	A	A	A		
Potassium dichromate, w	40	A	A	A	A	A	
Potassium iodide, w	S	A	A	A	A		
Potassium perborate	S	A	A	A	A		
Potassium permanganate, w	till 6	A	A	A	A		
Potassium persulphate, w	ac	A	A		A		
Potassium sulphides		A	A	A	A		
Potassium sulphite		A	A	A	A		
Potassium thiosulphate		A	A	A	A		
Propane, liquid	100	A					
Propane, gaseous	100	A		A			
Propargyl alcohol, w	7		A		A		
Propionic acid	50		A		A		
Pyridine		A	A	B	B		
Ricinene oil			A		A		
Rum	40	A			A		
Salicylic acid			A		A		
Salt- and sea-water		A	A	A	A	A	
Silicofluoric acid, w	till 32	A	A	A	A		
Succinic acid	S	A	A	A	A		
Sulphur		A	A	A	A	A	
Sulphur dioxide, dry	low	A	A	A	A		
Sulphuric acid	98	A		B			
Sulphuric acid, w	till 50	A	A	A	A		

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ALLPLAS - APPENDIX II - Chemical Resistance-Table

Product	Concentration %	Temperature 20° C (68° F) PP	PE-BB	60° C (140° F) PP	PE-BB	100° C (212° F) PP	PE-BB
Sulphurous acid			A		A		
Soap solution, w	conc.	A	A	A	A		
Sodium acetate		A	A	A	A		
Sodium bicarbonate		A	A	A	A	A	
Sodium bisulphate		A	A	A	A		
Sodium bisulphite, w	ac	A	A	A	A		
Sodium borate		A	A	A	A		
Sodium bromide oil (solution)		A		A			
Sodium chlorate	S	A	A	A	A		
Sodium chloride		A	A	A	A	A	
Sodium chlorite, w	50		A		A		
Sodium chlorite, w	5	A	A	A	A	A (80° C, 175° F)	
Sodium hydrochlorite	20	A	B	B	C		
Sodium cyanide	S	A	A	A	A		
Sodium fluoride		A	A	A	A		
Sodium hexacyanoferrates	S	A		A			
Sodium hydroxide	100	A	A	A	A		
Sodium hydroxide, w	10	A		A		A	
Sodium nitrate, w	S	A	A	A	A		
Sodium nitrite, w	S	A	A		A		
Sodium perborate	S	A	A	A	B	A	
Sodium silicate, w	ac	A	A	A	A		
Sodium sulphide, w	S	A	A	A	A		
Sodium thiosulphate, w	S	A	A	A	A		
Silver salts	S	A	A	A	A		
Silver nitrate, w	till 8		A		A		
Silicon oil	technical quality	A	A	A	A		
Soda water		A					
Soyabean oil		A	A	B	A		
Starch solution	ac	A	A	A	A		
Stearic acid		A	A		B		
Styrene			B		C		
Sugar solution	ac	A		A		A	
Sugar-beet juice			A		A		
Sugar-beet syrup		A	A	A	A	A	
Tannic acid	10	A	A	A	A		
Tallow		A	A	A	A		
Turpentine oil	technical quality	B	B	C	C		
Tetrahydrofuran	technical quality	B	B	C	C		
Tetralin		B	A	C	B		
Thiophen	100	B	B	C	C		
Toluene	technical quality	B	B	C	C		
Tomato ketch-up		A		A			
Tomato juice		A	A	A	A		
Transformer oil		A	A	B	B		
Tetrachlorethylene	100	B		C			
Triethanolamine		A	A	A	A	A (80° C, 175° F)	
Trichlorethylene	technical quality	B	B	C	C	C	
Trichloracetic acid, w	50	A	A	A	A		
Tricresyl phosphate		A	A		A		
Trioctyl phosphate		A	A		B		
Tetra ethyl lead		A					
Tartaric acid	10	A	A	A	A		
Two-stroke oil		B		B			
Tin chloride	S	A	A	A	A		

Product	Concentration %	Temperature 20° C (68° F) PP	PE-BB	60° C (140° F) PP	PE-BB	100° C (212° F) PP	PE-BB
Typewriter oil		A		A			
Urea	S	A	A	A	A		
Vaseline	technical quality	A	B	A	B		
Vinylacetate			A		A		
Vinegar	commercial	A	A	A	A		
Water		A	A	A	A	A	
Water, distilled			A		A		
Water glass		A		A			
Whisky		A	A				
Wine, mulled wine		A		A			
Wood preservative solution		A		B			
Whipped cream		A					
Xylene	100	B	B	C	C		
Zinc salts		A	A	A	A		

Key:

A – Resistant. Swelling below 3% or weight loss below 0,5%. Elongation at rupture not markedly inferior.

B – Limited resistance. Swelling 3–8% or weight loss 0,5–5% and/or decrease of elongation at rupture to less than 50%.

C – Not resistant. Swelling by more than 8% or weight loss more than 5% and/ or decrease of elongation at rupture to less than 50%.

No designations signifiy no test.

D = Degradation
W = Aqueous
s = Saturated
ac = Any Concentration
+ = Resistance dependent on composition

The information contained herein is offered for the guidance of the user. Recommendations and suggestions are, however, made without warranty. With this amended data sheet version old publications are not valid any longer.

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