

用于油漆及涂料生产的 新型分散技术 —— Conti-TDS

Conti-TDS - A New Dispersion Technology in Lacquer and Paint Production



高速分散机发明于上世纪中叶且仍在当今涂料的生产上使用。
此类设备存在许多缺点和制约，对成品有负面作用。

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德国YSTRAL公司的Conti-TDS 是一种新型的、先进的分散技术，已开始涂料生产上替代传统的高速分散机。这项新技术能够极大地降低生产成本和缩短加工时间，达到更高分散度，改善产品品质和节约原料等附加效果。相比之下，这项新技术使能耗降低至只有传统高速分散机的30%左右。

Conti-TDS技术

最后，这项新技术具有高度的灵活性而且可以按需求容易的扩展。与具有相同产能的传统高速分散机相比，投资成本低40%以上。

分散是油漆及涂料生产中最重要的工序，其对成品品质的影响最大。分散的效果越好，最终涂层中分散的颜料、填料、流变改性剂和所有其它功能添加剂的效率就越高。

传统的高速分散机是简单自由旋转的圆盘片，其圆周上有向上和向下弯曲的齿。由于旋转溶解盘与容器静态壁之间的距离较宽，剪切速率非常低：大约只有 50S^{-1} 。为了在如此低的剪切速率下产生剪切力，高速分散机要求非常高粘度的液体或至少该液体要具有剪切增稠或剪切膨胀的流变特性。

油漆与涂料具有完全不同的流变性：它们通常粘

Dissolvers were invented in the middle of the last century and have survived in lacquer and paint production until today. They have too many disadvantages, limitations and negative effects on final products.

YSTRAL's Conti-TDS – a new and advanced dispersion technology – has started to displace traditional high speed dissolvers in lacquer and paint production. This new technology enables enormous reductions in production costs and process times. Additional effects are a higher degree of dispersion, improved quality and raw material savings. The energy consumption is reduced to about 30% compared to the old dissolver technology.

Conti-TDS technology

Finally, this new technology is highly flexible and easy to expand if required. The investment costs are 40% lower than that of traditional high speed dissolvers with the same production capacity.

Dispersion is the most important process in lacquer and paint production and has the highest influence on the quality of final products. The better the dispersion, the higher the efficiency of the dispersed pigments, extenders, rheology modifiers and all other functional additives in the final coating.

Traditional high speed dissolvers are simple free rotating discs with up- and down-bent teeth at their circumference. Due to the wide distance between the rotating dissolver disc

度较低、具有剪切变稀和触变特性。高速分散机无法在低粘度油漆或涂料中产生显著的剪切效应。利用高速分散机进行剪切分散，需要极大调高产品的粘度。因此，高速分散机的搅拌分散过程开始时所需的增稠剂更多，并且只能加入部分液体以期获得更高的粘度。

这完全是矛盾的，因为需要分散的大多数成分都是非常精细的粉料（颜料、硅土、填料和填充剂），在添加最微细的粉料之前将液体制成超高粘度是荒谬的。粘度越高，对微细粉料的润湿与分散就越差。高粘度的液体不会进入最小的毛细管，也不能像低粘度液体一样快速和完全地润湿颗粒。其后果是形成稳定的结块，低质量，分散和研磨时间超长，产生热量和造成能量的浪费。

在分散开始时添加增稠剂有负面作用的另一个原因是大多数的增稠剂是剪切敏感的聚合物，在分散过程中，聚合物会有部分被破坏，它们的功效以不可控的方式下降。因此，增稠剂必须添加得比所需的更多。当溶解过程结束时，得到的是无控制的和不可预测的粘度。最后，粘度必须再次被调整。

德国YSTRAL公司Conti-TDS 技术是基于一种在线分散机，能够在高速和真空条件下吸入粉体，使其在液体中分散。该机器安装在工艺罐之外，高速循环液体，无需增设额外的进料泵（图1）。

机器的核心是装有高剪切部件的分散室。在该高剪切分散区能产生 $50,000\text{s}^{-1}$ 的剪切速率。这个剪切速率比高速分散机高1,000倍，因此不再需要调高液体粘度或额外增加增稠剂。

正是在这个区域，机器产生了一个非常强大的真空。利用这个真空，机器可以直接从袋子、解包站、料斗、桶、容器和大袋子中吸入粉体，使粉末进入液体。不再需要将不受控数量的粉末或来自液体的蒸汽抽入过滤器或排气系统的真空罐和真空泵。粉体吸入是无尘的，因为100%的粉末都会进入液体中，完全杜绝了工作区域的粉尘污染。

粉末被吸入液体循环回路，成为液状分散体到达容器。不再有灰尘出现在液体之上；不再出现部分浸湿的团聚体而结壳堆积在液体表面后又落入液体中，以及影响产品品质这类高速分散机的常见问题（图2）。

粉料在液体中的分散始终是在相等的、恒定的而且是受控的条件下进行的，与操作人员的动作快慢无关。产品质量可重复再现，即便对于不同大小的批量。

产品品质的恒定一直是高速分散机的最大问题之一。粒度、色强度、粘度、消光效应和成膜效果都受到操作者添加粉料方式的影响。不同批量，不同操作员，品质都在变化。较慢地添加粉体导致加工时间过长，温度更高，粘度更低；较快地添加粉体又会导致更多的结块和进一步延长加工处理时间，更长时间的剪切，更高的温度和更低的粘度。高速分散机的批次总是要经过质检-调整-再次质检和调整。这些步骤耗费了时间，且在等待质量检查结果的过程中延缓了工艺进程。



图 1: YSTRAL Conti-TDS 与循环罐和大袋解包站
Figure 1: YSTRAL Conti-TDS with process tank and big-bag station

and the static wall of the vessel the shear gradient is very low: just about 50 reciprocal seconds. To create shear forces with such a low shear rate, a dissolver needs a very high viscous liquid or at least a shear thickening or dilatant rheology.

Lacquers and paints have exactly the opposite rheology: they are low viscous, shear thinning and thixotropic. A dissolver cannot create significant shear in a low viscous lacquer or paint. To shear with a dissolver, the viscosity has to be increased extremely. For that reason, the dissolver process starts with more thickeners than required and just a part of the liquids to get a higher viscosity.

This is completely paradox since the most ingredients which have to be dispersed are very fine powders (pigments, silica, fillers and extenders). Making a liquid extra high viscous before adding finest powders is absurd. The higher the viscosity, the worse the wetting and dispersion of fine powders. A high viscous liquid will not get into smallest capillaries and cannot wet fine particles as fast and complete as a low viscous liquid. The consequences are stable agglomerates, low qualities, extra-long dispersing and milling times, heat generation and a waste of energy.

Adding thickeners at the beginning of the process is negative for another reason: most thickeners are shear-sensitive polymers. During dispersion, the polymers get partially destroyed. The effect goes down in an uncontrolled manner. For that reason, you have to add more thickeners than required and you get uncontrolled and unpredictable viscosity levels at the end of the dissolver process. Finally, you have to adjust the viscosity again.

YSTRAL's Conti-TDS technology is based on an inline dispersing machine which is able to induct and disperse



图 2: YSTRAL Conti-TDS 与液体和粉体连接
Figure 2: YSTRAL Conti-TDS with liquid and powder connections

Conti-TDS的一些结果

Conti-TDS可以生产出完全均一恒定的产品质量。粘度是恒定的，增稠剂也不会被破坏，这意味着通常高达20%的增稠剂可以省去，这个数量也是通常被过量添加和被高速分散机长时间溶解所破坏的量。

图3显示了钛白粉的吸入和分散的典型粒径分布。

powders into liquids under high speed and vacuum. The machine is installed outside the process tank and recirculates the liquid with high speed. Additional pumps are not required (Figure 1).

The core of the machine is the dispersing chamber equipped with high shear tools. In the high-shear dispersing zone, it creates a shear rate of 50,000 reciprocal seconds. The shear rate is 1,000 times higher than that of dissolvers. High liquid viscosities or additional thickeners are not required.

Exactly in this zone, the machine creates a very strong vacuum. With this vacuum, it inducts powder directly from bags, bag tipping stations, hoppers, drums, containers and big bags into the liquid. No vacuum tank and no vacuum pump is required which pulls uncontrolled amounts of powder or effluent vapour out of the liquid into filters or exhaust systems as it happens in vacuum dissolvers. The induction is dust-free because 100% of the powder goes into the liquid. Dust pollution of the working area is completely avoided.

The powder is inducted into the recirculating liquid loop and arrives in the vessel as a liquid dispersion. No dust appears above the liquid; no partially wetted agglomerates and crusts are built up above the liquid surface and then fall into the liquid and reduce product quality, that is a common problem with dissolvers (Figure 2).

The dispersion of the powder into the liquid is always done under equal, constant and controlled conditions, independent from the speed of the operator. The product quality is absolutely reproducible, even for different batch sizes.

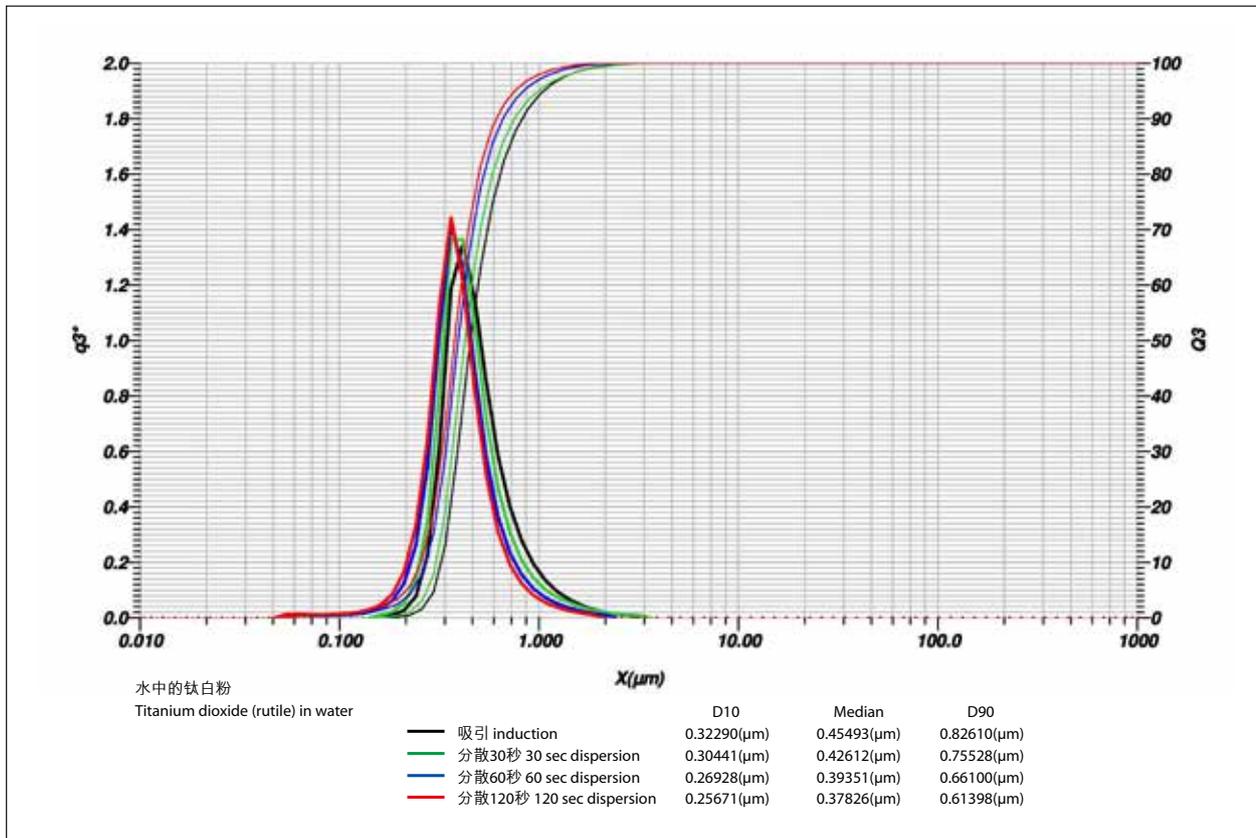


图 3: 钛白粉被吸入后分散 30 秒、60 秒和 120 秒的粒径分布
Figure 3: Particle size distribution titanium dioxide having 30, 60 and 120 seconds of dispersion after induction

在粉体被吸入后可立即获得比高速分散机和研磨机生产的参考样品更好的结果。中位粒度已达到 $0.46\mu\text{m}$ 。99.9%的粒子小于 $2\mu\text{m}$ 。没有任何大的粒子可见，粒径分布很窄。经120秒延时分散后中位粒径下降至 $0.38\mu\text{m}$ ，100%小于 $2\mu\text{m}$ 和98%小于 $1\mu\text{m}$ 。

使用Conti-TDS生产的二氧化钛分散体的色强度总是要高很多。因此，与高速分散机相比，即便减少二氧化钛的用量都有可能达到更好的品质性能。

二氧化钛是生产油漆、涂料和油墨最重要的颜料。它覆盖了全球颜料59%以上的需求。钛白粉的价格自2009年以来就处于上涨。使用Conti-TDS加工钛白粉的厂商报告获得大量的节省。由于更好的分散，他们节省了时间、能耗以及大量的原料。

对于所有其它颜料、消光剂、填充剂和填料，都能被分散得更快，效果更好——同样也适用于所有水性和溶剂基的油漆、涂料和印刷油墨。

安装和运行

机器安装在与一台工艺罐循环连接的回路中。如此，机器的运行不受罐体大小和罐的料位影响。如需以最小的附加成本使产能加倍，可将一台机器安装在两台工艺循环罐之间（图4）。只需要一台机器，一个控制系统以及增加一个粉料加料点就可以使产能翻番。

在一个循环罐的生产过程期间，另一个循环罐已排空上一个批量并加入下一个批量的液体。平均在完成粉料吸入后的50秒内，已达到所要求的粒径而且产品已准备转移。当本批次的产品准备排料时，机器自动切换至第二个循环罐并开始处理。这样，即使在连续不间断的生产中只用一台机器就可能达到每小时生产20,000kg以上的成品涂料。

所有Conti-TDS系统都具有集成的和涂料行业认可的自动清洗单元。为了保持过程系统始终清洗每个单一批次，过程系统包含一个清洗步骤。通过清洗喷头加入一部分工艺液体，保持循环罐和所有相关部件的清洁。即使下一批次是相同的产品，循环罐也会被自动清洗。如果在不兼容的原料或不同颜色之间进行产品更换，则可以额外增加清洗液体。

在工艺循环罐内部，安装有高效的捷流混合器，它能垂直推动和转动液体。这些混合器能起到瞬时均化的作用。因为粉料是高速添加的，所以这一作用非常重要。以水平旋转为主的简单搅拌器难以达到均匀混合，也不够快。

经济优势和灵活性

除了技术优势外，这款新型Conti-TDS技术也具有明显的经济优势。与高速分散机工艺相比，涂料的生

Constant quality has been one of the biggest problems with dissolvers. Particle size, colour strength, viscosity, matting effect and film formation are influenced by the way how the operator adds the powder. The quality varies from batch to batch, and operator to operator. Slower powder addition caused longer process times, higher temperatures, and lower viscosities. Fast addition causes more agglomerates and further processing time, longer shear, higher temperatures and lower viscosity. Dissolver batches always need to be quality checked – adjusted – checked and adjusted again. These steps take time and block the process tanks during waiting for the QC results.

Some results with Conti-TDS

The Conti-TDS produces absolutely constant qualities. The viscosity is constant. And thickeners are not destroyed – which means that often up to 20% of the thickener can be taken out. This is the amount which is typically over dosed and destroyed by the long dissolver process.

Figure 3 shows a typical particle size distribution for the induction and dispersion of titanium dioxide.

Immediately after induction, the result is better than reference samples produced with dissolver and mill. The medium particle size is already at $0.46\mu\text{m}$. 99.9% of the particles are below $2\mu\text{m}$. Not any oversized particle is visible. The distribution is very narrow. After 120 seconds of additional dispersion, the medium particle size reduces to $0.38\mu\text{m}$. 100% are below $2\mu\text{m}$ and 98% are below $1\mu\text{m}$ (Figure 3).

The colour strength of the titanium dioxide dispersions produced with Conti-TDS is always higher. For that reason, the amount of titanium dioxide may be reduced with even better performance than dissolver dispersions.

Titanium dioxide is the most important pigment in lacquer, paint and ink production. It covers more than 59% of the global pigment demand. The prices for titanium dioxide have been rising since 2009. Companies which use Conti-TDS for titanium dioxide have reported about enormous savings. They save time, energy and a significant amount of raw materials because of better dispersion.

But even all other pigments, matting agents, extenders and fillers are dispersed faster and with better results – it also apply to all water borne and solvent-borne lacquers, paints and printing inks.

Installation and operation

The machine is installed in recirculation with a process tank. This way it operates independently from vessel size and filling level. To double the capacity with minimum additional costs, one machine is often installed between two vessels (Figure 4). You need just one machine, one control system and one powder addition point to double the production output.

During production in one vessel, the other vessel is discharged from the last batch and filled with the liquid for the next batch already. In the average of 50 seconds after finishing the powder induction, the required particle size is reached and the product is ready to transfer. When the batch is ready to discharge, the machine automatically switches over to the second tank and starts the process there. In this



图 4：位于两台工艺储罐之间的 ContiTDS-5
Figure 4: ContiTDS-5 between two process tanks

产成本通常降低10%。此外，因为分散更好、着色强度更高和所需的增稠剂更少，原料用量可以显著减少。通常可将生产时间缩短到20%。因此，用户报告节省超过35%的能源。一般来说，ContiTDS保证了更高的产品质量，更高的生产灵活性和更高的安全水平。

一台ContiTDS的占地面积只有几个平方米。由于更快的加工速度，一台ContiTDS能够在非常小的空间上替代多台高速分散机。

投资费用相比低许多。对于一台新的装置，与传统高速分散机相比，投资成本大约不到其60%。投资回报一般不超过6个月。另一个优点是项目实现时间短：通常从决定到投产运行只需要半年到一年的时间。

当前，灵活性越来越重要。采用这样的系统，可以非常有效地制备不同的配方和大小可变的批量。由于设计紧凑，很容易实现未来产量扩大的需要。

由于机器的操作不受工艺罐大小的影响，如果需要，可以将来增大工艺罐。因此，只需要更换工艺罐和工艺罐上的混合器——再不用其它的了。系统的核心——ContiTDS和其自动控制——保持不变。

这些机器已经在业界的所有领域中得以极为广泛的应用。所有类型的产品，所有粘度范围和所有类型的原料都被加工过。如果未来有全新的要求，工艺的重组也很容易。

生产出来的油漆和涂料的成品质量至少可以相等，在大多数情况下，比传统高速分散机更好。

way, it is possible to produce up to 20,000kg of finished paint per hour with just one machine, even in a continuous and uninterrupted production.

All ContiTDS systems have an integrated and paint industry approved automatic cleaning unit. To keep the process system always clean, every single batch requires a cleaning step. A part of the process liquid is added through the cleaning heads and keeps the tank and all relevant parts clean. Even if the following batch is the same product, the vessel is cleaned automatically. Additional cleaning with extra liquid is possible if there is a product change between incompatible materials or different colours.

Inside the process tanks, there are high effective jet stream mixers installed which move and turn the liquid vertically. These mixers provide an instantaneous homogeneity. This is important because of the high speed powder addition. Simple agitators with mainly horizontal rotation are not able to mix the liquid homogeneously and are not fast enough.

Economic advantages and flexibility

Additional to the technical advantages, there are obvious economic advantages with this new ContiTDS-technology as well. The production costs of paint are typically reduced 10% compared to the dissolver process. Additionally, a significant reduction in raw materials is possible because of better dispersion, higher colour strength and less thickener demand. A reduction of the production times to below 20% is typical. Consequently, 35% energy savings are reported as well. Generally, the ContiTDS guarantees higher product quality, higher flexibility in the production and higher level of safety.

The foot print of a ContiTDS system is just some square meters. Because of the faster process, one ContiTDS can always replace a number of dissolvers – on a very small space.

Investment costs are lower. For a new installation, the investment costs are about 60% lower compared to conventional dissolvers. The return of investment is often shorter than six months. Another advantage is the short realisation time: normally, it takes just between half year and one year from the decision to the production.

Today, flexibility is getting more and more important. With such a system, it is possible to produce very effectively different formulations and variable batch sizes. Because of the compact design, it is easy to expand the capacity if required in future.

Since the machine works independently from the vessel size, it is possible to enlarge the process tanks in future if required. Therefore, just the process tanks and their mixers are exchanged – nothing else. The core of the system – the ContiTDS and the automatic control - remains untouched.

The machines are already used in all fields of the industry in an extremely wide field of applications. All types of products, all viscosity ranges and all types of raw materials are processed. If there are completely new demands in future, it is easy to restructure the process.

The final product quality of the produced lacquers and paints is at least equal, in most cases are better than those produced by traditional dissolvers.

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