High Quality Paint Filtration Point of Application - Automotive Base Coat

Introduction

One of the most demanding facets of manufacturing an automobile is the proper application of the exterior finish. The coating is applied for appearance and customer satisfaction. However, the coating also provides protection by reducing corrosion, which in turn improves the appearance and increases the life of the automobile body. To maximize both appearance and corrosion resistance, contaminants must be reduce from the paint prior to application. An optimized paint filtration system will reduce contaminants from the paint thus reducing rework (repainting), improving the finish quality and significantly reducing manufacturing costs. This Customer Application Brief (CAB) presents the benefit of using an effective base coat filtration system.

Description of the Application

The process begins with a thorough washing of the vehicle body followed by a multiple layer painting process consisting of an electrodeposition (ED) protective dip coating, a primer or anti-chip layer, a base coat (metallic or solid color), and the final clear protective coat. Contaminants present in any of the layers compromise finish quality and often result in costly rework of the defective area. Figure 1 below is a schematic of a typical base coat filtration process.

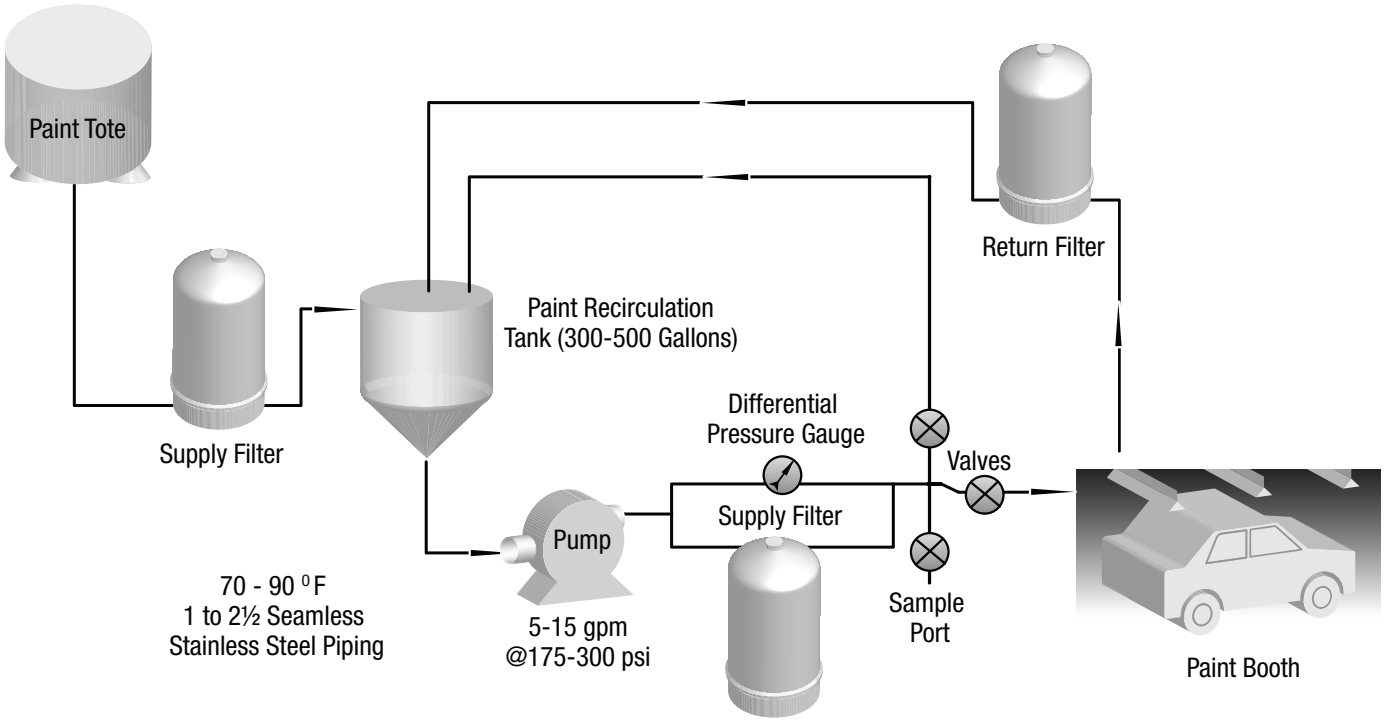


Figure 1. Typical Filtration System Schematic

Potential Problems

Defects resulting from particulate are one of the most common and costly problems associated with the application of the base coat in automotive assembly plants. These defects are defined as anything that creates an imperfection in the coating, changing the way light is reflected or refracted, thereby harming the appearance of the surface finish. This is especially noticeable for glossy surfaces which then becomes magnified with the applications of the topical clear coat. Since today's automotive films can be as thin as 20 microns, small particles less than 20 microns are significant and have a considerable impact on the quality of, and customer satisfaction with, the automobile's finish. The two main types of particle caused defects are often classified as dirt and craters.

Types of Defects

Dirt: Often includes weld spatter, metal fines, sanding dust, fibers, oven "dirt", gel particles, pigment flocculation, floor dust, etc.

Crater: A crater (Figure 2) is a depression in the surface finish and includes defects, commonly known as fish eyes. Craters can be caused by resin gel particles, dirt, filter material and poorly dissolved or dispersed additives.

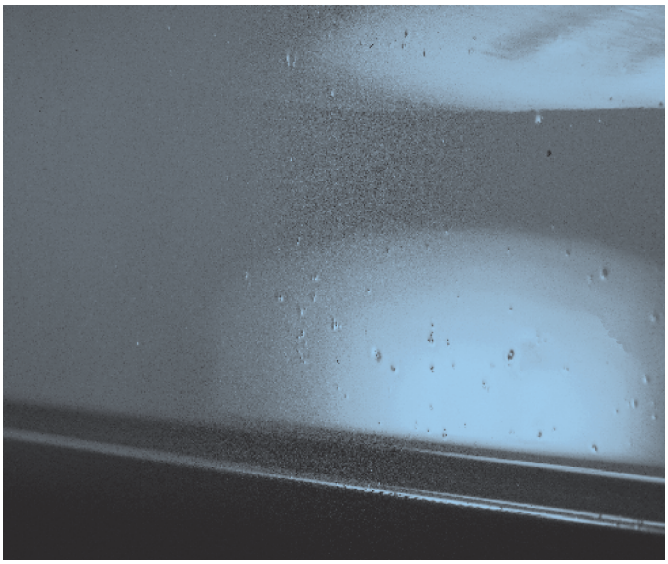


Figure 2 — Fish eye defects

Source of Defects

Dirt or particulate can come from a variety of sources. Despite efforts at the paint manufacturing to properly filter the paints, many contaminants originate in the production of the paint. Contaminants are also present in the assembly plant and the sources include sanding dust, fibers from wipes, clothing, air borne dirt, and overhead conveyers. An additional source of dirt is that brought into the work area by employees from the pollen on their cloths to the personal hygiene products they use.

Paint Contamination

Dirt and particulate can be introduced during the application of the automotive paint at a variety of locations. These include the tote, the transfer line from the tote to the paint recirculation tank, old paint released from the inside of the supply and return piping (Figure 3). Ineffective contamination control at any of these points results in defects and necessary product rework.

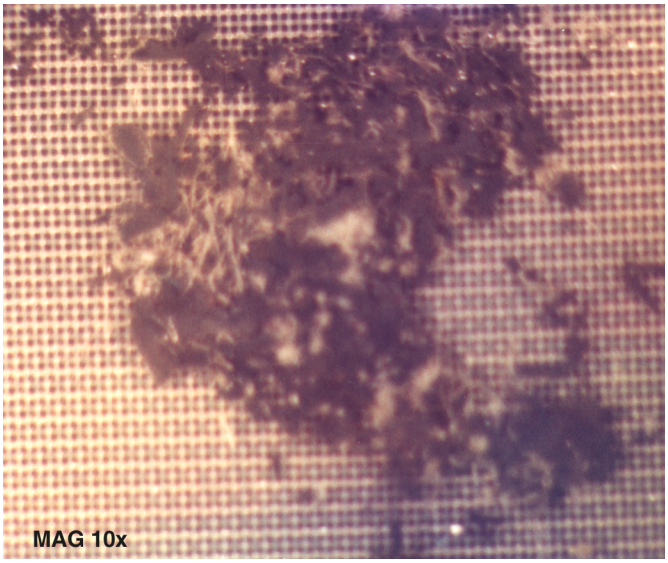


Figure 3 — Dirt Captured on a Screen from a Basecoat Recirculation Line

Cost of Defects/Rework

Automotive assembly plants deal with dirt caused defects in several ways. These include:

Accept Them (Poor Quality Product) - This can result in peeling, blistering paint and poor film appearance. In today's competitive market coupled with the customers demand for quality this is no longer an acceptable option.

Minor Rework (Buffing) - This is where the defects in the film can be reduced or made less visible by simply buffing the surface. The process may compromise the finish and also delay the shipment of the automobile.

Major Rework (Sand & Repaint) - This can be limited to sanding and repainting a small area or it may require sanding and repainting of the entire automobile. This adds significant cost to the vehicle, due to lost production time, increased inventory, added material costs and non-value added processing steps, quality and, therefore, customer satisfaction, are also affected as the repair will never match the finish of an automobile which does not require rework.

Reworking adds significant cost to the manufacture of an automobile. An average assembly plant can spend $5,000,000 per year because of lost production time and scrap caused by dirt and craters. Base coat rework compromises the quality of the final finish, as the refinished surface is difficult to match after sanding. This in turn, changes the film appearance making proper color matching difficult to obtain since different lots of paint are often used. The typical result is inferior appearance and protection compared to an original paint finish.

Filtration

It is essential to reduce contaminant from the base coat before it is applied to the automobile. Filtration is a key manufacturing stop in providing a defect free film. Paint filtration is complicated since the filter must allow small particles in the dispersion such as pigment, metal flakes, micas, and fillers to pass through the filter but trap the larger unwanted particles. This filtration method is referred to as classification. The typical reduction efficiency of a classifying filter is shown in (Figure 4). This compares to clarifying filtration where all particulate and a broad particle size distribution are reduced (Figure 5).

Commonly used bag and melt blown filters reduce a high percentage of the particles below the filter rating. In coating applications these clarifying characteristics are highly undesirable since they typically strip desired pigments, metallics, micas, and fillers from the paint. The result is a poor coating along with short filter life, (i.e., increased filter change-out, increased disposal costs and higher filter inventories).

Figure 4—Classifier
Reduced nearly all 20 µm and larger particles, while allowing nearly all particles smaller than 20 µm to pass.

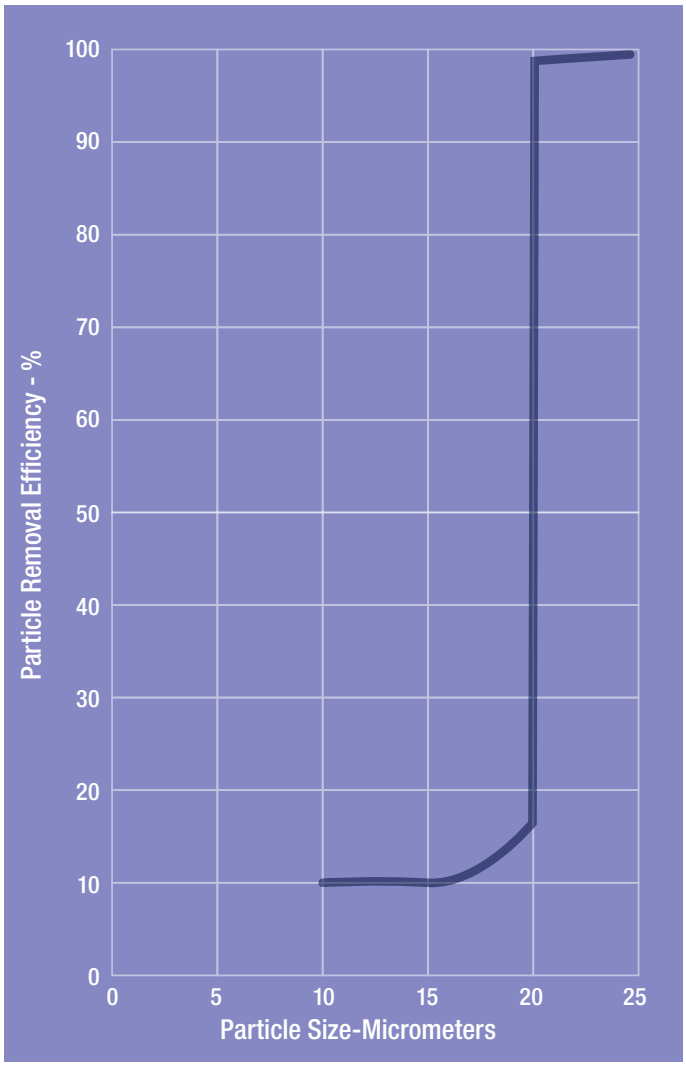
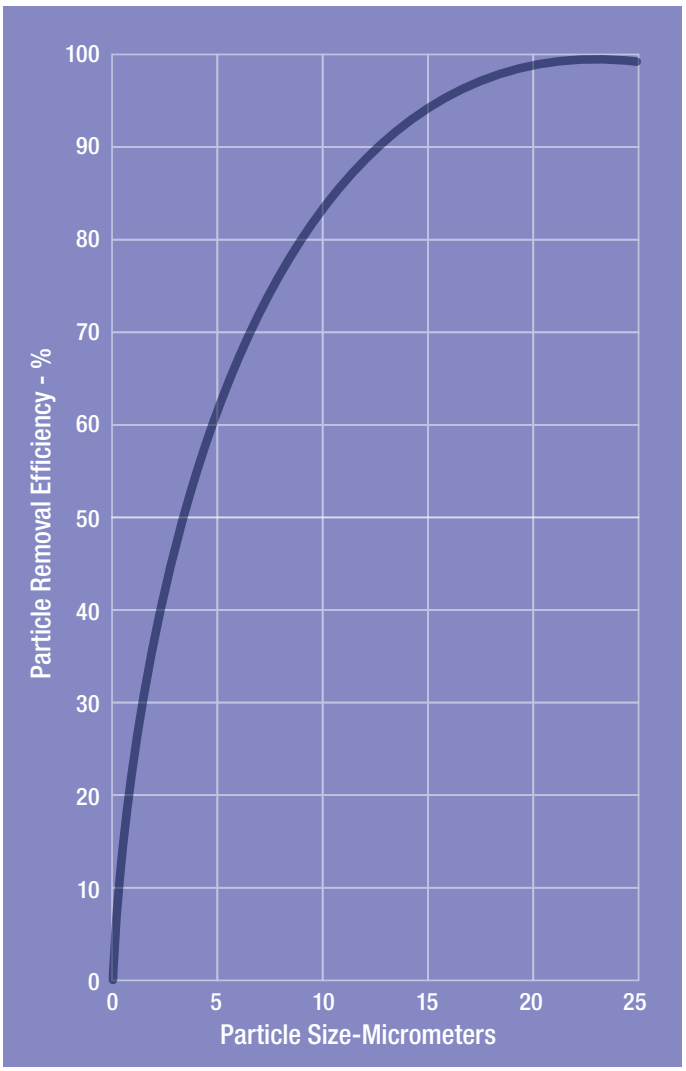


Figure 5—Clarifier
Reduced nearly all 20 µm and larger particles, but also removed a large amount of particles smaller than 20 µm.



Betapure™ AU Series Filter Cartridges

A true, absolute-rated classifying filter is 3M's Betapure™ AU series, which is ideal for base coat applications (Figure 6). It reduces undesirable contaminants while allowing pigments, metallic flakes, micas, and fillers to pass through. Betapure AU series is available in a wide range of filter grades, tightly and accurately rated for narrowly differentiated filtration needs.

The rigid structure reduces pore size changes, unloading, and bypass that are common with other filters. Betapure AU series is supplied in polyolefin or polyester based materials - both compatible with automotive paints.

Figure 6 —Betapure™ AU Series Filter

Betapure AU Series Product Advantages

Maintains paint quality by selectively passing desired pigments, metal flakes, and mica while reducing larger contaminants; superior classification characteristics of Betapure AU series.

Contaminants will not unload or bypass into the paint; rigid non-deformable filter structure.

- Reduces oversized particles that would require rework of the automobile; absolute rated.
- Reduces gels and deformables that cause craters and fish eyes.
- Helps reduce fibers from paint; free of media migration.
- Helps reduce filter change-outs during the batch; increased filter service life.

Filtration Location

The proper use of Betapure AU series filters at the locations identified as the supply and return filters in Figure 7 will significantly reduce the incidents of particulate and dirt caused defects in the application of the base coat. These locations include:

Tote transfer - filtration of the paint as it is being transferred from the shipping tote to the recirculation tank in the paint kitchen

Paint Kitchen - filtration of the paint being supplied to the spray booth and again as it is being returned into the recirculation tank

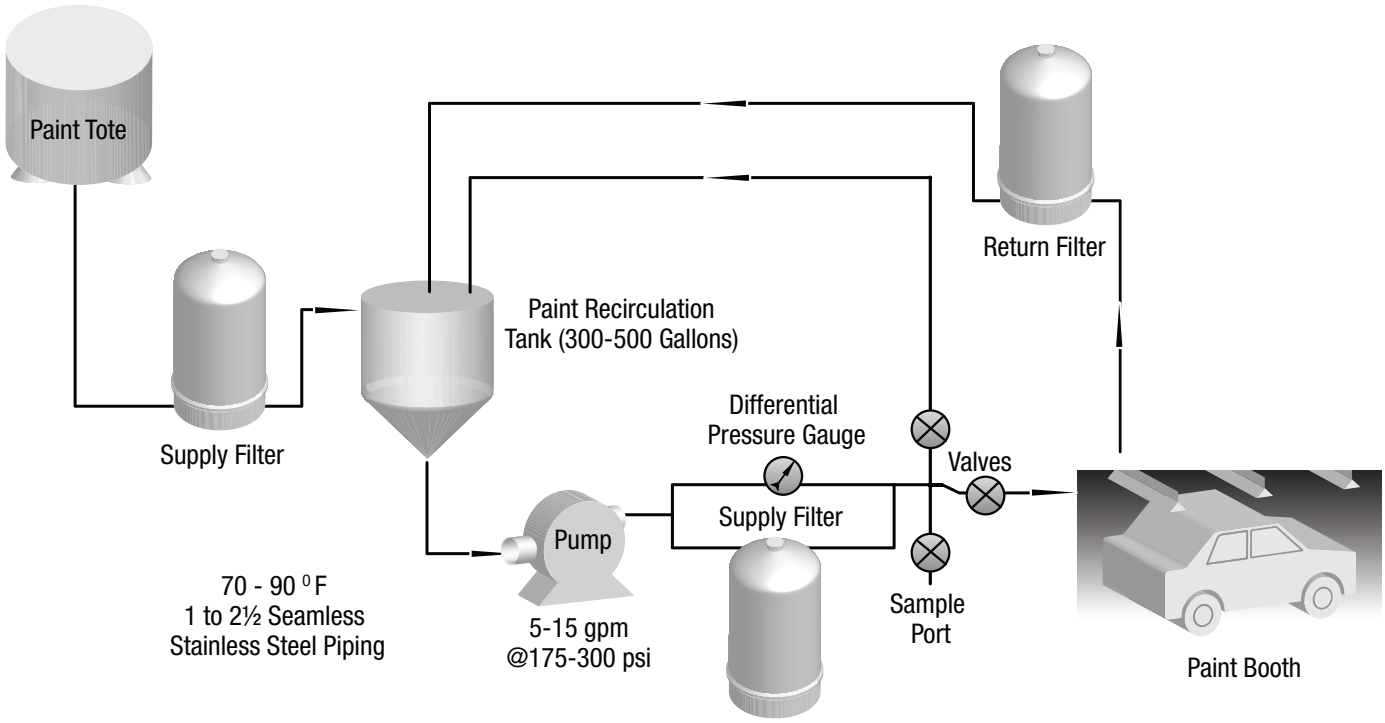


Figure 7 — Typical filtration Locations in a Base Coat Application

Case Study

The use of 3M's Betapure™ AU series, a rigid classifying filter, has provided significant operational savings when compared to commonly used products referred to as melt blown and bag filters. One such application is as follows:

A Year Long Filter Study 3M Purification versus Nylon Mono-filament (NMO) bags

A major US automotive assembly plant was using nylon NMO bags as the primary filter in the paint recirculation loop. The NMO bag, a non-rigid, surface filter, has various features that are often detrimental to the effective filtration of the paint. They are:

Poor Contaminant Reduction

The bag is capable of reducing solid cylindrical contaminants but will easily pass contaminants such as deformable particles or gels (causing craters, fish eyes & seeds) and small diameter long contaminants like fibers.

Short Service Life

Bags must be changed at low differential pressure (less than 15 psid) to avoid rupture and paint contamination.

Bags have a very low dirt holding capacity thus requiring frequent change-outs resulting in additional paint loss, increased labor, and increased filter disposal and purchase costs.

Construction

NMO bags utilize a thread to sew the seams of the filter. During the thread manufacturing process a lubricant, typically silicone, is required. If the thread is inadvertently produced with silicone lubricant severe paint surface defects will occur.

The selection of the proper filtration system must take into account the process parameters and the quality demands of the application. If this is done correctly, the contaminant will be reduced from the paint, the vehicle quality will be met and the overall process costs will be reduced.

The information in Table 1 describes the operating conditions of a year long study at a U.S. Assembly plant. The study evaluated two waterborne base coats (a solid and a metallic paint) under the following conditions.

Table 1 —Process Conditions

	Solid Paint		Metallic Paint	
Process Conditions	Betapure™ AU Series	NMO Bag	Betapure™ AU Series	NMO Bag
Flow Rate	6 gpm	6 gpm	7 gpm	7 gpm
System Pressure	180 psig	180 psig	180 psig	180 psig
Viscosity	85 cps	85 cps	73 cps	73 cps
Temperature	78 °F	78 °F	78 °F	78 °F
Filter	40 µm abs. BP	25 µm	160 µm abs. BP	100 µm
Change-out criteria	16 psid	16 psid	16 psid	16 psid
Service Life	6 weeks	1 week	6 weeks	1 week

Actual Savings

The cost savings obtained by reducing rework is listed in Table 2. The data illustrates that Betapure™ AU series, when used to filter a solid paint, instead of a bag filter reduced rework from 10 automobiles per 100 to 5 automobiles per 100 (a 50% reduction in rework). Similarly, when filtering a metallic paint, Betapure reduced rework from 20 automobiles per 100 to 14 automobiles per 100 (a 27% reduction in rework).

Table 2 —Rework Reduction

	Solid Paint		Metallic Paint	
Process Conditions	Betapure™ AU Series Filters	NMO Bag	Betapure™ AU Series Filters	NMO Bag
Automobile Acceptance (cars per 100)	95	90	86	80
Automobiles Requiring Rework (cars per 100)	5	10	14	20
Rework Reduction (cars per 100)	5		6	
Improvement in Compliance	50%	--	27%	--

From the data in Table 2 an average improvement in rework was 5.5% yielding an overall annual rework savings of $1,650,687.
(350 vehicles/day x 5.5 vehicles/100 improvement in rework x $350 average cost of rework per vehicle x 245 work days per year = $ 1,650,687)

The process cost savings obtained by converting to the 3M Betapure™ AU series and 3M™ CT series filter housing are listed in Table 3. The data is based on a paint kitchen with 20 paint lines and related annual expenses with flow rates to 15 gpm and provides the details on how the costs are calculated.

Table 3 —Process Costs

Process Issue	3M Purification Filtration System	Bags
	Capital Cost for a 15 GPM System	
20 Housings	$12,000	$12,000
Installation for 20 Systems	$5,000	$10,000
Total Capital Costs	$17,000	$22,000
One time capital savings using 3M™ CT Series filter housings	$5,000	
	Annual Expense	
Media Expense (A/B x C x D)	$4,000	$19,200
Labor to change-out filters (A/B x C x E x F)	$865	$15,600
Lost paint during filter change-out (A/B x C x G x H)	$4,500	$45,000
Disposal Cost - [(A/B x C x G/I) + (A/B x C/J)]K	$2,175	$7,450
Total Annual Expense	$11,540	$87,250
Annual Savings using 3M Betapure™ AU series filters	$75,710	

A = 48 work weeks per year	G = Lost paint during filter change-out (gallons): Betapure 3/8, Bags 5/8
B = Filter Life: Betapure AU series 6 weeks, Bags 1 week	H = $75 per gallon paint cost
C = 20 paint lines	I = 55 gallon disposal drum
D = Cost of media: Betapure AU series $25, Bags $20	J = Filters per 55 gallon drum: Betapure 49, Bags 240
E = Time to change-out filters(hours): Betapure AU series 0.083hrs, Bags 0.25hrs	K = $500 per 55 gallon drum disposal cost
F = $65 hourly rate	– ––

Conclusion and Summary

The one-year study conducted at a U. S. assembly plant clearly demonstrates the cost savings potential achieved by simply improving the filtration of the automotive base coating. The combined Rework Reduction (Table 2) and Process Costs (Table 3) provided the plant that produced 350 vehicles per day annual savings of $1,726,397.

Recommendations

To optimize paint quality, the key filtration locations in the automotive assembly plant that should convert to 3M 's Betapure™ AU series filter cartridges are:

The filter from the shipping tote to the paint recirculation tank, the supply filter from the paint recirculation tank to the spray booth, and the return filter from the spray booth to the paint recirculation tank.

Please contact your local 3M Purification distributor for information on how to conduct a test and obtain similar savings.

Scientific Applications Support Services

The cornerstone of 3M 's philosophy is service to customers, not only in product quality and prompt delivery, but also in validation, application support and in the sharing of scientific information. 3M Purification's Scientific Applications Support Services works closely with customers to solve difficult filtration challenges and to recommend the most efficient, economical filter systems. SASS specialists can perform on site testing and utilize filtration applications expertise to partner with customers. 3M resolves filtration problems promptly and efficiently in a cost-effective, confidential manner. 3M Purification's broad distributor base and sales offices provide worldwide customer service, local inventory, and field support in virtually every major center of manufacturing.

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