

Honeywell

PRE-DISPERSED FLUX CONCENTRATE FOR CONTROLLED AIR BRAZING OF ALUMINUM

A Clean Solution for Excellent Joint Formation and Low Post-Braze Residue





Flux powder dust scattered across the floor of a brazing area at a customer site.

Introduction and Challenges

Working with fine powders is a challenge. Powder spillage results in workplace contamination with fine dust particles, whether automated or manual transfer systems are used. The CAB brazing of aluminum heat exchangers under a controlled atmosphere of nitrogen, requires the use of a potassium fluoroaluminate salt that acts as a flux during the brazing process. This well-established industrial process has been employed since the 1980s, and the brazing industry has adapted manufacturing processes to mitigate the challenges associated with using fine powder fluxes. Nevertheless, the implementation of these techniques did not completely eliminate contamination. Optimization of flux application methods is constrained by the need to sufficiently disperse and break up agglomerates of powdered flux. Continuous stirring of a flux dispersion is required to maintain homogeneity and prevent sedimentation. Agglomeration of flux particles and settling cause blockages, which contribute to process downtime and the need for cleaning and maintenance of equipment.

In response to customer requests for innovative flux technology to improve safety, enhance process robustness and add value, Honeywell developed a pre-dispersed flux concentrate. Handling of powdered flux is eliminated to promoting a clean and safe manufacturing environment. The Honeywell flux concentrate (Al-Flux 2805 600) is easily diluted with deionised water to create a dispersion of discrete flux particles with a low sedimentation rate suitable for dip or spray application. The unique properties of the Honeywell flux concentrate enable further innovation and refinement of spray application systems, thereby enhancing deposition accuracy, reducing flux overspray, improving material utilization, increasing brazing quality, and ensuring overall cost saving.



Honeywell flux product characteristics.

Background

Molten filler metal does not naturally wet an oxide film, and as such, the most important step in aluminum brazing is the disruption of the surface oxide. This is achieved by the application of a potassium fluoroaluminate flux, which melts below the melting point of filler metal. During brazing, molten flux facilitates the wetting, spreading and flowing of molten filler metal into the gap between two parts to form a brazed joint. The flux also helps inhibit oxidation of the metal surface.

A minimum amount of flux applied uniformly to activate the surface is desired. As spray fluxing process technology advances, tighter control of the physical properties of flux become necessary to improve accuracy of application and reduce waste. The flux particle size range determines the ease of handling and type of equipment that can be used. Very small flux particles (less than 5 micron in size) would be preferred, but are very difficult to handle as powders and thus are generally excluded. Larger flux particles are easier to handle, but constrain equipment selection and are difficult to keep in a homogenous dispersion without agitation. If the flow through pipes feeding spray nozzles is interrupted, flux settling causes blockages and alters the volume and uniformity of flux deposited on parts. Consequently, nozzles with larger orifices are used to prevent these problems. This limits control of the volume passing through a nozzle, resulting in an excess deposition of flux solution on components.

The use of excess flux is not only wasteful, but can also contaminate brazed joints and cause drips from parts during the brazing process — contaminating the furnace and other components. Defective brazing conditions due to inadequate or poorly applied flux include post-braze discolouration, poorly formed brazed joints characterised by porosity and, in some cases, the lack of a brazed joint at all.

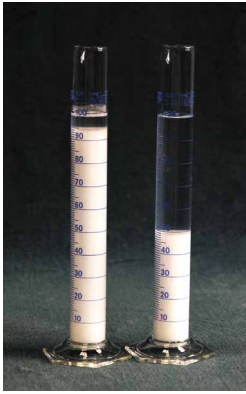
Honeywell has supplied a proven powdered flux for the aluminum brazing industry for more than 25 years. Its highly reactive flux has a very low melting onset (up to 25°C below the Al-Si eutectic filler metal) enabling more time for surface reactivity to disrupt the oxide and promote brazed joint formation. Good flux reactivity enables lower flux loading. Honeywell flux concentrate Al-Flux 2805-600 features a narrow, carefully controlled particle size range and a high batch-to-batch consistency. The flux is easily dispersed in solution to form a slow-settling mixture. This makes control of low flux loadings attainable and the application process more robust.

Flux Concentrate Development

Motivated by customer requests to eliminate handling of powder flux in the brazing process, Honeywell has developed an aqueous thixotropic gel/paste system with a stable dispersion chemistry retaining all the positive attributes of Honeywell flux powder.

Honeywell flux concentrate Al-Flux 2805-600 is a high solid content, stable thixotropic paste of pre-dispersed flux containing surfactants and dispersion additives. This concentrate of discrete hydrated flux particles includes extremely small particles that would normally be too small for safe practical use with powdered flux. It can be stored without the risk of particles separating from the liquid. The flux concentrate was evaluated under extreme environmental storage conditions without showing any deterioration and has proven to have a long shelf life. Storage conditions ranged from well below freezing temperatures in winter to hot temperatures in summer.

The thixotropic properties of the flux concentrate allow for dispensing with conventional pneumatic or positive displacement pumps. The concentrate can be used for localised application, or diluted with deionised water into a stable dispersion for spray or dip application. Pre-weighed packages of Honeywell flux concentrate Al-Flux 2805-600 are available for dilution in the supplied pail. Mixing the flux concentrate to form a dilute dispersion can be achieved with simple, low-cost mixing equipment such as a gyroscopic mixer. There is no need for high-shear mixing.

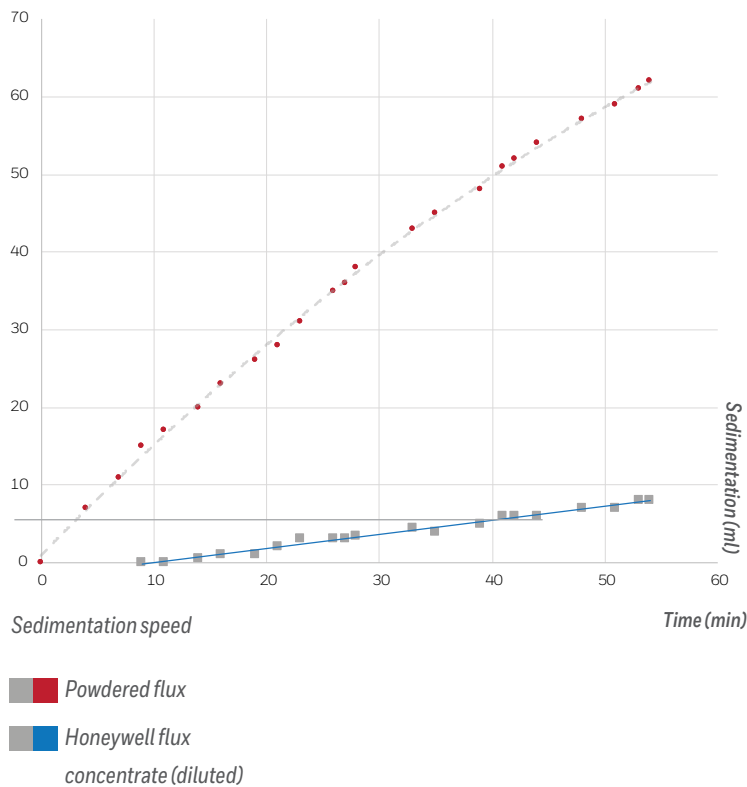


Flux Application

When diluted, the Honeywell flux concentrate forms a stable flux suspension with a very low sedimentation rate compared to powdered flux mixture. This stable suspension of pre-dispersed flux concentrate lowers susceptibility of pipes to blockage and hard sediments forming in process equipment. Only low-velocity stirring or agitation are needed to maintain dispersion homogeneity. Process equipment is also easier to clean and maintain, thereby improving productivity and decreasing downtime.

The physical properties of the flux suspension were carefully designed with the Honeywell solution. The low viscosity and small, discretely dispersed flux particles in the diluted suspension allow the use of finer atomising nozzles to deliver a high-velocity, finely atomised droplet stream. The improved atomised droplet control and deposition accuracy limit overspray. Full surface wetting and uniform coverage by diluted suspension can be achieved with a lower volume, resulting in a reduced amount of water in the brazing line and a shorter drying time. Overall flux loading can subsequently be reduced while maintaining or even improving brazing quality.

Sedimentation characteristics



Brazing Benefits

Incorporating very fine particles in the flux concentrate improves surface coverage and coating morphology, which further enhances the brazing reactivity of Honeywell flux concentrate. The small flux particles melt faster during the brazing cycle, activating the surface so that molten filler metal can wet, flow and be drawn into the gaps between components to form brazed joints. Improvement of braze joint quality was observed with lower flux loadings. Additional benefits of Honeywell flux concentrate include post-braze surfaces with a smoother topography and shiny appearance. With lower than usual flux loadings, solidified flux agglomerates and unreacted flux residues are minimized and, consequently, post-braze cleaning may not be necessary.

Post-braze surface



Economic Advantages

Replacing powder flux with Honeywell flux concentrate provides cost savings and increased value. Costs associated with the use of powder flux can be reduced by as much as 50 percent. This is achieved by eliminating powdered flux handling, simplifying the mixing process, enhancing application accuracy, reducing the amount of flux, and minimizing workplace contamination. The results are improved productivity and reduced downtime, while maintaining and, in some cases, improving brazing quality.

	TCO ELEMENTS	POWDER FLUX (PREVIOUS)	HONEYWELL AL-FLUX 2805-600 (IMPROVED)	TOTAL SAVINGS (1000 UNITS)
Health & Safety	Health & Safety	Risk	Risk mitigated	\$1,000
Logistics	Handling	Time wasted (to minimize work place contamination)	Easier and faster	\$50
	Cleaning	Work place contamination	No dust or particulate generation	\$700
	Packaging	0.5 man-hours for cleaning before disposal	100% eliminated	\$50
	Flux Utilization	2-5% loss	< 1%	\$15
Dispersion Preparation	Flux Dispersion Preparation	1.5 man-hour per day	66 % reduction	\$700
	Quality Assurance	4-6 potential errors to control (one per comp.)	75-85 % less errors to control	\$2100
Application	Flux Application	One blockage per shift, 30 minutes downtime	> 2 weeks without block	\$45,000
	Overspray	2.7% overspray	0.5% overspray	\$6500
	Flux Coating	35g/unit	27g/unit	\$65000
Brazing	Reject rate	10-15%	1%	\$65000
	Fixtures lifetime	Corrosion & cleaning	Twice service life	\$8000
	Productivity	100%	120-130%	\$135000

Conclusion

Honeywell developed a refined, waterborne system for the supply of a new flux concentrate to overcome many of the issues the aluminum brazing industry had with powdered flux.

Honeywell flux concentrate is a thixotropic, pre-dispersed flux system that can be diluted to form a stable suspension with a low sedimentation rate to improve the industrial brazing process.

Use of the concentrate promotes a clean and safe manufacturing environment, optimizes flux utilization, simplifies operations, contributes to high brazing quality, and adds overall customer value.

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