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Stainless Steel Bulletin for Bio-Fuels/Biomass
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Achieve 25-30% Savings Using LDX 2101® over 304L

Because of the higher yield strength of Outokumpu's new lean duplex stainless steel LDX 2101®, structural engineers and fabricators in the biofuels and biomass industry can now reduce wall thickness in tanks and vessels. This reduction in wall thickness means significant savings—not only in material weight and cost, but also in supporting structures for tanks as well as in the handling and welding process during construction.

Ethanol facilities, like this expansion project are using Outokumpu's LDX 2101® lean duplex to achieve significant cost savings.

The newly developed grade of stainless steel, LDX 2101, boasts two important chemical composition adjustments (from 304L) that help the grade achieve mechanical strength twice that of 304L while still offering comparable corrosion-resistance, along with ease and stability of welding and machining. LDX 2101 gets its corrosion resistance from its high chromium content. As Elisabeth Torsner, Outokumpu's VP Market Development recently wrote in a paper for Corrosion Engineering, Science and Technology, "Stainless steel relies on its invisible, exceedingly thin, passive film of chromium oxide to protect its surface against the onset of corrosion. Chromium is the basis for all corrosion resistance, by definition at least 10.5% Cr, the more chromium the higher corrosion resistance." LDX 2101 contains 21.5% chromium compared to 18.1% chromium in 304L.

Not only is LDX 2101 heavy on chromium, it is light on nickel. LDX 2101 was initially developed to address the volatile cost of nickel while offering an alternative in corrosion resistance to 304L. LDX 2101 contains 1.5% nickel compared with nickel content of 8.2% in 304L. The reduction in nickel content offers better price stability to the purchaser, when he/she has to consider several purchases over a longer period of time and it adds confidence in budgeted material prices vs. actual purchase prices. Table 1 shows the typical chemical compositions of some stainless steel grades, including many of the duplex grades proprietary to Outokumpu.

Typical Chemical Compositions of Some Stainless Steel Grades

Grade	UNS	EN	C	N	Cr	Ni	Mo	Others	Micro-structure	PRE	CPT °C
304L	S30400	1.4307	0.03	0.10	18.1	8.3	0.3		A	19	
LDX 2101®	S32101	1.4162	0.03	0.22	21.5	1.5	0.3	5 Mn	D	26	18
2304	S32304	1.4362	0.02	0.10	23	4.8	0.3	—	D	26	20
316L	S31603	1.4404	0.02	—	17.2	10.1	2.1	—	A	24	20
2205 Code Plus Two®	S31803/ S32205	1.4462	0.02	0.17	22	5.7	3.1	—	D	35	55
904L	N08904	1.4539	0.01	—	20	25	4.3	1.5 Cu	A	34	55
254 SMO®	S31254	1.4547	0.01	0.20	20	18	6.1	Cu	A	43	85
2507	S32750	1.4410	0.01	0.27	25	7	4	—	D	43	85
4565	S34565	1.4565	0.02	0.45	24	17	4.5	5.5 Mn	A	46	90

® Registered trade names by Outokumpu
A= Austenitic structure; D= Duplex (austenitic-ferritic) structure
PRE= %Cr + 3.3x%Mo + 16x%N
CPT= Critical Pitting Temperature tested according to ASTM G 150

Developed by the research & development team at Outokumpu —a leading producer of stainless steel—LDX 2101 is ideal for the corrosive environments of the biofuels and biomass industry. LDX 2101 has already been specified as a construction material for ethanol production applications including pressurized piping and vessels such as jet cookers and large fermentation and storage tanks in projects in the U.S., Sweden, the Netherlands, Belgium, France, and Australia.

For example, the Swedish company, Agroetanol AB, recently expanded a major ethanol plant using LDX 2101 sheet and plate in construction of wheat fermentation and storage tanks. A biodiesel and ethanol plant in Amsterdam is using 1,500 tons of LDX 2101 and 500 tons of lean duplex grade Outokumpu 2304 for a similar expansion project. “When one is buying stainless in these kinds of volumes, an incredible cost savings can be realized—in some cases 25 to 30%—simply by specifying LDX 2101 over 304L,” noted Torsner. To view Elisabeth Torsner’s entire paper “Solving Corrosion Problems in the Bio-fuels Industry” click on this link.

New Tool To Calculate Savings with Duplex

Specifying engineers can now use the storage tank shell thickness calculator available on the Outokumpu web site to estimate the weight saving potential of the use of duplex grades, such as Outokumpu’s lean duplex LDX 2101®, compared to austenitic grades.

Nine Common Corrosion Issues Solved by Stainless

There's a reason why biofuels and biomass producers are major consumers of stainless steel. Contamination and corrosion issues are chronic throughout biofuels processing—from pre-treatment to storage tanks and distribution lines. Outokumpu's stainless steel grades are being used in nine different areas within ethanol plants where contamination and corrosion can occur.

Fuel-grade ethanol represents a unique set of corrosion issues including contamination from pre-treatment through storage and distribution. For ethanol, the chlorides used in the production process (particularly at high temperatures) can cause stress corrosion cracking specifically found in the distillation column and the stillage dryer/heat exchanger. Chlorides may also cause chimney corrosion. But Outokumpu's duplex grades of stainless steel are almost insensitive to stress corrosion cracking. Resistance to stress corrosion cracking in duplex grades is equaled only by the highest alloyed austenitic grades such as 904L and 254 SMO®. Additionally, ethanol itself is corrosive to materials including aluminum, carbon steel, and rubber.

Another area of corrosion concern in ethanol plants is cleaning at high temperature with high pH-value agents. As Elisabeth Torsner, Outokumpu's VP Market Development, explained, "The corrosion problems faced here are similar to those in the pulp and paper industry, in which Outokumpu has a long history of providing new grades of stainless steel to solve process problems." Duplex grades have shown, in both testing and in practical application, to have better corrosion resistance than their austenitic counterparts in such hot alkaline environments. Outokumpu is a leading producer of stainless steel in plate, pipe, coil, bar, sheet, and fittings forms. To view Elisabeth Torsner's paper "Solving Corrosion Problems in the Bio-fuels Industry" click on this link.

Nine Common Corrosion Issues

In her white paper for Corrosion Engineering, Science and Technology, Elisabeth Torsner, Outokumpu's Vice President Market Development, listed nine specific ethanol production areas where stainless steel is being specified to combat contamination and corrosion:

- Mixing tanks for enzymes and water
- Liquefaction
- Pressurized cooker
- Fermentation tanks
- Distillation columns
- Molecular sieves
- Stillage dryer/heat exchanger
- Piping
- Finished product storage tanks

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Outokumpu is a global leader in stainless steel. Our vision is to be the undisputed number one in stainless, with success based on operational excellence. Customers in a wide range of industries use our stainless steel and services worldwide. Being fully recyclable, maintenance-free, as well as very strong and durable material, stainless steel is one of the key building blocks for sustainable future.