WHAT IS “DROSS”?  
Dross is a reaction product which is formed from Mg treatment and during subsequent reoxidation of Mg rejected from the molten metal before it solidifies. It is therefore just another word for a specific type of slag (reaction product).

The reaction binds magnesium with sulphur, oxygen and silicon and forms continuously. This “dross” is light weight and so it will generally be found in the upper surfaces and under cores, but it can be entrained throughout the metal as well, especially with colder pouring temperatures.

It is very difficult to completely avoid the reaction of magnesium with these other elements, since we need magnesium to form nodules. We are always confronted with the problem of dross in the production of Ductile Iron.

When looking at “dross” in the microscope you will almost always find flake graphite in association with the dross. The reason for this is insufficient magnesium due to the reaction of magnesium with other elements. Dross also occurs in the form of long stringers instead of concentrated “slag like” areas. When it occurs in this string like form it acts like cracks or flake graphite in the structure and so fatigue strength and impact strength of the material are lowered considerably.

WHAT IS PROMOTING “DROSS” AND WHAT CAN BE DONE TO KEEP THE “DROSS” OUT OF THE CASTING?  
Since “dross” is always connected with magnesium, it is necessary to keep the magnesium level as low as possible. Good inoculation practice with some late inoculation in conjunction with sufficient magnesium will produce nice round small nodules. See Suggestion Sheet 76.
If the CE (Carbon Equivalent) is high there is more danger to promote “dross”. The use of stronger inoculation materials and some late inoculation will usually require a smaller overall addition allowing for lower silicon content and a lower CE. Most inoculants are supporting the formation of “dross”. So this is another reason to keep the addition amount as small as possible.

All reactions change with changes in tapping and pouring temperatures. The amount of dross formed is significantly increased at lower temperatures. Heavy-sectioned castings normally are cast at low temperature to reduce primary shrinkage. This therefore increases the possibility to find more dross, since Si can oxidize on the surface of the iron specifically at these lower temperatures and reacts with Mg. In general then it is advisable to cast Ductile Iron castings “hot”. The use of a safety riser (on riserless castings) can compensate for the additional primary shrinkage seen.

“Dross” is also formed because of turbulence in the treatment, pouring from the treatment ladle to the pouring ladle and during filling of the mould. The filling of the mould is best done so that the iron is entering the mould from the bottom side. Since there is a high temperature loss during filling of the mould, you should use enough or larger ingates to fill the mould quickly with the minimum amount of turbulence. One possible cause is from having too small a downspur for a given choke area.

The gating system is the place where the melt can “pull” oxygen through the moulding sand which will form “dross”. Therefore the gating system should be always a pressurized filling system. Dross can even form in the runner system on the way to the mould cavities. Therefore it is good to place filters at a location just before the iron is entering the mould cavity. The choke should be directly at the gates or the filter. Sometimes it is necessary to use ceramic inserts or tile to form the gating and filling system. Lap type defects and “elephant skin” surface defects are extreme examples of magnesium silicate dross formed at low pouring temperatures.

“SMOOTH METAL FLOW IS NECESSARY FOR CLEAN CASTINGS”

The cleanness of a melt is directly related to the charge materials and melting practice. If you use rusty, oxidized charge materials, such as can occur in thin steel scrap, there is the danger to get more slag and a high amount of undissolved oxides in the melt. Today, more melting is done in medium frequency furnaces where you have less stirring/movement during the melting operation than in main frequency furnaces and you will then find more of these products in the melt.

The Mg treatment and type of treatment alloy has a great influence on the formation and quantity of dross. It is suggested to use a treatment process where you have a high Mg yield. As the total amount of magnesium is reduced you will get also less dross. Since the “dross” is a small and low-density product, which is “swimming” in the melt, it needs a long time to rise up to the surface. To bring the “dross” quickly out of the melt you have to coagulate the “dross” by having high turbulence in treatment (higher Mg content alloys) or to use materials to coagulate the reaction products in the melt which will help to clean the iron.

For additional information about reducing dross in your castings consult Rio Tinto’s publications on Ductile Iron Production and Gating & Risering System Design.