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Thread: A2 heat treating, warping parts! **4** Lili[View First Unread](#) [LinkBack](#) [Thread Tools](#) [Search Thread](#) [Rate This Thread](#) [Disp](#)

05-09-2012, 12:16 PM

Mike_
AluminumJoin Date: Dec
Location: Kansas C
Posts: **A2 heat treating, warping parts!**

So I've got a little problem, these parts are driving me up the wall!!





This is what I'm getting, this part here was wrapped and stuck in a cold oven. I turned it on, let it get to temp (1775 degrees,) soaked for 45 minutes and pulled to air cool.

It's bowed like a banana, real bad!

The part I did before this was done almost the same way, except I stuck it in the oven after it was at temp. I let it soak for about an hour. It did the same thing, bowed almost exactly the same.

The last time I ran these I had the same exact problem. I tempered them while bolted down to the fixture I used to mill them and the bend relaxed a lot. This took a long time, the oven only cools so fast and there's only one fixture.

If I were to take a big plate, and sort of pre-spring these parts in the opposite direction of the bow (using that middle tapped hole) would it be reasonable to think the bend would relax during tempering? Am I asking for trouble? I've got quite a bit of time in these things and I don't want to have to do them all over again because they're bent!

I'm also slightly worried about them cracking or blowing out around the tapped hole. As I said earlier I managed to pull the bend out against my fix last time without them breaking, but that was with 100% support on the convex side. The plate I'm thinking to rig up real fast would only support them on the high side of that arc.

Also, (this should have been my first question!) are there any tips or tricks to keep A2 from warping while hardening? If I could keep them straight through that process I would imagine they would stay true through tempering. I've tried slowly bringing the heat up and just chucking it in the fire cold. Both have the same results and I'm out of ideas.

Thanks in advance!

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05-09-2012, 12:26 PM

toolmaker96 ◉
Cast Iron

Join Date: Jul
Location: Carson CI
Posts:



I think you need to look at stress relieving then finish machine, then heat treat. Or even better, hard mill after ht.

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05-09-2012, 12:30 PM

old dog ◉
Aluminum

Join Date: Nov
Location: Mtn.Hor
Posts:



I have had some luck holding it at 1350 for a while and then bringing the furnace to the finish temp.

[L](#)

sfriedberg likes this.		
05-09-2012, 12:47 PM		
TGTool Aluminum	Join Date: Location: Posts:	Sep Still Okla
 What about clamping them between flat ground mild steel plates and heat treating the whole shebang. I'd be inclined to park the sandwich in front fan for cooling, even though it's air hardening. IIRC we did some parts this way if they were skinny and prone to bowing.		
77ironhead and BR3 like this.		
05-09-2012, 01:05 PM		
Mike_ Aluminum	Join Date: Location: Posts:	Dec Kansas C
 Originally Posted by toolmaker96 <i>I think you need to look at stress relieving then finish machine, then heat treat. Or even better, hard mill after ht.</i> I tried this last time, I turned the convex radius on a lathe and they bowed like crazy when I pulled them off the fixture. I tried stress relieving, (ca remember the exact details) and then milled the other side. They still liked to bow after heat treating, and in the same direction. There's only aroui 30 thou of meat that gets taken out on the concave side, after the lathe work that is, is that insignificant enough to be considered finish machine? I'd rather not get into hard milling! They changed the radius on these parts at some point and sent some hard ones back to us to modify. I ended up making a fixture to grind them to size... Originally Posted by old dog <i>I have had some luck holding it at 1350 for a while and then bringing the furnace to the finish temp.</i> I brought the oven to 1450, but as soon as it got there I raised the limit to the full 1775. How long do you let them sit at 1350 for? Does half a soa time sound good? Originally Posted by TGTool <i>What about clamping them between flat ground mild steel plates and heat treating the whole shebang. I'd be inclined to park the sandwich in front of a fan for cooling, even though it's air hardening. IIRC we did some parts this way if they were skinny and prone to bowing.</i> This is going to be my last ditch effort, my oven isn't very big and I probably can't fit a whole order in one shot. Did you ever have a problem with t threads for your clamps pulling at those temps though? Thank you all for the tips so far! I really appreciate it!		
05-09-2012, 01:12 PM		
wrustle Stainless	Join Date: Location: Posts:	Jur Massachi
 We make some pretty fussy parts out of A2 material that requires heat treating and have absolutely no problems at all. Parts are .375" x .625" x 4. lg. and need to be flat and parallel within .002". We completely finish machine them then send them out for heat treat which consists of vacuum harden, draw and glass bead to clean. Parts come ba go through inspection, and out of the 80 or so pcs we get back we need to grind in only about 25% to get back within the .002 tolerance. We've use the same treating house for years and years, and they do a GREAT job with all our parts. I realize the parts are smaller than what you have there, but perhaps it's your heat treating procedure that's causing the problems because I can honestly say, I've never had any issues heat treating A2 and having it move like that. Any parts we've ever made are always made to size and sent for heat treat, and with the exception of the job I mentioned none need to be worked afterwards. Later, Russ By the way, we just did another order of these last month. My cost from the vendor, \$91.63 for the lot of 22lbs.		
05-09-2012, 02:19 PM		
Spencer in NH Hot Rolled	Join Date: Location: Posts:	Jar Southern Ham



Describe what the part is sitting on in the oven. Is there a rack??

LI

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05-09-2012, 08:08 PM

Teggy1 
Plastic

Join Date: Apr
Location: Iowa
Posts:



How are you cooling them?

I had issues with some 1X2X36 inch A2 pieces, cooling them on a cooling table (squirrel cage fan under expanded metal table). I literally had to bail sit them, turning them from one side to another as they cool. Obviously, the surface that is cooling the fastest is contracting more, thus warping yo parts, so rotate them. Also, after reading a little more regarding heat treat of tool steels, forced air is not necessary for A2 (although the shop I wor in used the cooling table religiously).

Also, not that I believe this will have much if any affect, but I have always gone by the rule of 1hr soak time per inch of material thickness, with a : minimum.

ETA: In summary, I believe you are warping them during cooling NOT during the heating cycle.

LI

TDeegenhart likes this.

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05-10-2012, 01:25 AM

WILLEO6709 
Titanium

Join Date: Nov
Location: WAPELLO, I
Posts:



I'd do 2 things.... first, you need to keep the stresses even when macining. If that means milling 0.030 off 2 sides instead of 0.060 off 1 do it. Secoi be sure you have it in the oven" the rigid way". Keep it the most rigid way as t sits in the oven, the most rigid way on the cooling rack, and keep airflow consistant around the thing in cooling. You can stack a bunch of them together, bolt them thru the holes to hold them together and harden : one solid block. If you are starting with flat ground I'd find a different supplier, that stuff is not stress relieved for nothin.

LI

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05-10-2012, 06:24 AM

77ironhead 
Titanium

Join Date: Jar
Location: ma
Posts:



 Originally Posted by **TGTool** 

What about clamping them between flat ground mild steel plates and heat treating the whole shebang. I'd be inclined to park the sandwich in front of a fan for cooling, even though it's air hardening. IIRC we did some parts this way if they were skinny and prone to bowing.

where I work, we clamp *everything* that has a chance of bending (IE long & thin). the parts get clamped, wrapped, run through the oven, and air cooled (including a cooling fan blowing on them) while still clamped. In most cases, they get run through tempering still clamped, as well.

To the OP: why on earth are you turning these on a lathe? Am I missing something here? The parts shown look like a simple block with a couple of tapped holes.

LI

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05-10-2012, 06:47 AM

toolmaker35 
Aluminum

Join Date: May
Location: North Texas
Posts:



Quote by WILLEO6709 "You can stack a bunch of them together, bolt them thru the holes to hold them together and harden as if one solid block."

That's the best way that I've found to do flat, thin parts. One piece acts as a brace for another. This also works exceptionally well on oil hardening steels that would otherwise turn into a pretzel when quenching.

LI

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05-10-2012, 09:45 AM

gwilson 
Diamond

Join Date: Oct
Location: williamsb
Posts:



I never ever have had trouble with A2. Are you exposing all the large surfaces to the heat equally,as in not just laying them flat on the oven floor? That might cause warping. Also,A2 hardens just fine in STILL air. I have used a fan,but still air gets the same results without risking cooling too

rapidly,so I do not risk a fan anymore.

Li

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05-10-2012, 09:52 AM

TDegenhart 
Stainless

Join Date: Mar
Location: Geneva Illinois
Posts:



One thought. Have you tried cycling the part through the HT process but *leaving the part in the furnace to cool gradually* as in annealing?

Tom

Li

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05-10-2012, 09:05 PM

David Utidjian 
Titanium

Join Date: Mar
Location: Mahwah
Posts:



Mike,

Judging by the degree of warpage in your parts as pictured there is something else going on here that simply bolting may or may not fix but... A2, when processed correctly is not supposed to warp to that degree, especially across the width of the part (2nd picture). One of the nice things about using A2 and air cooling is that it has much less tendency to warp and crack than the other water and oil quenched tool steels. I would find it difficult to warp a piece of W1 the way your piece has warped if I was trying to do it deliberately, much less A2.

Others have already listed some concerns and made some suggestions. I disagree with the idea of using fans or some sort of draft for the quench. All manufacturers of A2 that have a recommended process for their material specifically say to quench in room temperature *still* air. Some manuals on heat treating I have read mention using drafts but more likely to distort the parts due to uneven application.

I don't know what you are starting with but it appears that your stock may be some standard size and you are simply cutting to length, drilling, tap and deburring before heat treat. If that is the case, then the problem is either in your material to begin with or your heat treatment process. As someone has suggested... if you are milling or grinding either the top or the bottom some amount then you should take equal amounts off of both sides rather than all off of one side. That might explain the long bend along the length of the part.

One of the quickest and cheapest ways to determine if the warping is caused by your in-house heat treatment process or not is to send a batch of test parts to a heat treating service and when they are finished compare them to yours. If they still warp in the same way and to the same degree it is in the material and/or machining process. If the parts come back perfect (or nearly so) then it is in your heat treatment process.

The heat treatment process:

On your next batch (or single piece) start with a cold furnace.

Set up the furnace so that the piece will be supported a long its length but is still off the floor of the furnace. Several round or triangular cross section chunks of firebrick or suitable ceramic will do. That piece looks to be at least 10-12 inches long so I wouldn't go any further than a couple of inches without a support.

The piece should be wrapped snugly in stainless foil or in a bag. If in a bag fold the sides in so that the piece is snug. Doesn't have to be super tight you don't want a lot of dead air around it.

Set the thermostat or process controller for 1200F and turn on the heat. As soon as the furnace comes up to 1200F check through a peephole or on the door a crack to get a glance at the part. The part and the bag should have a uniform color that matches the surrounding furnace walls. The bag may appear a little dark on the edges and corners. If the whole thing is still a bit darker close it up and wait about five minutes then check again. Check it is mostly a uniform color start timing it. It should sit at the preheat temperature for about 15 minutes. There is no advantage to letting it preheat longer. As soon as the 15 minutes is up set the controller for your austenizing temperature of 1775F.

Once the furnace reaches that temperature take a peak at the part. You may need to use some sunglasses if it looks too bright to your eyes. The important thing is the part at a uniform temperature (same color as walls and supports.) Again the edges and corner of the bag may look a little darker. If not close it up and wait another five minutes. Check again. Once it is to temperature start your timer again. That part looks to be about 1/2 inch thick so I would let it soak at 1775F for about 45 minutes. This gives you plenty of time to get ready for the quench step.

For quenching you need a flat rack. I use old cooking oven racks supported off of the bench a few inches by some bricks, *this is important*. Once the furnace door is opened the part should come out of the furnace and go directly on to the rack. It should not spend some time sitting on the floor or a flat metal bench or on some bricks. It should go straight to the rack. Have the gloves, face shield, tongs, snips, etc... all setup and handy. Your gloves should be welders style gloves. The tongs should be long handled and be able to grip the part securely. You will need the snips to cut open the bag at the part of the quench.

So you are all ready... you have gloves on, faceshield on, rack is ready, workspace is clear, no one is talking to you about the last night's game, the tongs are in your hands and ready to go.

Once the 45 minutes is up: Open the door and immediately pull the part out and place it flat on the rack. This should only take about 3 seconds, 5 seconds tops. Close the furnace door and turn it off.

The part will (obviously) be glowing bright orange but will quickly cool down. Since it is air-hardening the quench started the instant you pulled it from the furnace. At this stage most of the heat is being given off by radiation. The temperature of the air around it is pretty uniform. You never want to dump an air-hardening steel on to a cold or insulating surface such as a steel plate or brick or concrete.

Do NOT remove the part from the bag yet.

You must wait until the part no longer glows. Look underneath the part while it is on the rack. If you no longer see any glowing color, just dull gray, you can now snip the bag open with the snips and slide the bag off leaving the part on the rack.

If you wrapped the part really tight you could just leave it in the bag until you can handle it with gloves. If it is sorta loose in the bag then it is best to remove it.

Just let it cool. No fans, no breezes, no HVAC vents.

According to the W.E. Bryson book the part should not get below 150F before it is tempered. 150F is just hot enough to be almost painful but you can still hold on to the part. Don't drop it. One of those little infrared reading guns is handy at this point. My furnace takes a long time to cool down from 1775F to about 500F even with the door open so I just put the parts on top of the furnace until it is cool enough for tempering. If you have a separate tempering oven all the better.

Put the part in the tempering oven (or your furnace) once the oven has reached the correct tempering temperature *with the door closed*. If your

furnace is like mine and the door has been open to cool it down to, say, 500F then as soon as I close the door the temperature shoots back up a few hundred degrees. So if my tempering temperature is 500F I let my furnace cool down to about 200-300F and check with the door closed. I set the controller to 500F and let it stabilize at that temperature. Then I put the part in and close the door. Once the controller says it is back to the correct tempering temp I start the timer and let it temper for about an hour. You can go longer but there is no advantage to it. Once an hour is up take the part out and let it sit on the rack.

With the above procedure my parts come out within few thousandths (sometimes less) over the major dimensions from when they went in.

-DU-

LI

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